final report

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Prioritisation of weed species relevant to Australian livestock industries for biological control

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Abstract

Classical biological control is the only realistic option for managing many of the most serious weeds affecting livestock industries in Australia. This project developed and applied a framework, based on a matrix assessment system, to prioritise biocontrol efforts using new agents against 79 weed taxa. These taxa were identified in a concurrent project as priorities for Research, Development and Extension to address weed problems of Australian livestock industries. The framework considered the current and potential impacts of the weeds versus prospects for biocontrol. The latter combined assessments of feasibility of undertaking a biocontrol program that would yield host-specific agents, and the likelihood that agents would be successful in mitigating the impacts of the weeds once released in Australia. Each categorisation was supported with a written rationale that explained the ranking assigned and captured uncertainties. Key investment areas for future actions to address biocontrol knowledge gaps for each weed were identified. Twenty-one weeds with the highest combined rankings for biocontrol prospects and current and/or potential impacts were shortlisted as priority taxa for future investment. Results provide the best available information for funding agencies responsible for RD&E for livestock industries to make investment decisions across their weed biocontrol portfolio.

Executive summary

Weeds affect livestock industries in many ways. The financial impact (yield losses and costs of control) of weeds on livestock industries in Australia was estimated to be more than $2 billion a year in the early 2000s. Classical biological control (biocontrol) is the only realistic option for managing many of the serious weeds affecting these industries. Indeed, the livestock industries have had a long history of investment in weed biocontrol in both northern and southern Australia. It is critical though that weed targets are carefully selected by assessing them against likely return on investment in biocontrol.

This project's goal was to develop and apply a framework, based on a matrix assessment system, to prioritise biocontrol efforts using new agents against 79 weed taxa. These taxa were identified in a concurrent project, supported by MLA, as priorities for Research, Development and Extension to address weed problems of Australian livestock industries. The framework considered the current and potential impacts of the weeds on livestock industries versus prospects for biocontrol. The latter combines assessments of feasibility of undertaking a biocontrol program that would yield host-specific agents, and the likelihood that biocontrol agents would be successful in mitigating the impacts of the weeds once released in Australia. The framework also included devising explicit *a priori* goals for the biocontrol program of each weed. These goals served to help assess the likelihood of success of biocontrol and could ultimately be used to assess the success of biocontrol programs should they be implemented. Definitions and guidelines were developed to guide assessment of all components of the framework.

The main advantage of the prioritisation framework is its transparency – each categorisation is supported with a written rationale that explained the ranking selected and captured any uncertainties or qualifications in the ranking. Key investment areas for future actions/research that specifically address biocontrol knowledge gaps for each weed were also identified. Potential investment areas to enhance the efficacy of already released biocontrol agents or to explore non-classical biocontrol approaches were considered separately from the prioritisation framework.

An expert elicitation and consultative approach, involving other Australian biocontrol practitioners and ecologists in a workshop environment, was taken to gather the necessary information and opinions to process each weed through the prioritisation framework. Following cross-checking and review by the project team, the compiled information, categorisations and explanations for each weed were circulated to workshop participants for additional comments, which were taken into consideration in finalising results.

Twenty-one weeds with the highest combined rankings for biocontrol prospects and current and/or potential impacts were shortlisted as priority taxa for future investment. For example, to be shortlisted, weeds with low current and/or potential impacts had to have at least moderate-high biocontrol prospects, whereas high impact weeds were included even if biocontrol prospects were low-moderate.

The shortlisted weeds, grouped by prospects for biocontrol, are:

- High: *Chromolaena odorata.*
- Moderate-high: *Cirsium vulgare*, *Marrubium vulgare*, *Moraea flaccida* and *M. miniata*, *Opuntia* and *Cylindropuntia* spp., *Prosopis* spp.

- Moderate: *Carduus tenuiflorus* and *C. pycnocephalus*, *Euphorbia terracina*, *Lantana camara*, *Lycium ferocissimum*.
- Low-moderate: *Bryophyllum delagoense*, *Jatropha gossypiifolia*, *Nassella neesiana*, *Physalis viscosa*, *Romulea rosea*, *Solanum elaeagnifolium*, *Vachellia nilotica* ssp. *indica* (syn. *Acacia nolitica* ssp. *indica*), *Ziziphus mauritiana*.

This shortlist includes relatively minor weeds where biocontrol prospects are good, as well as the most serious weeds for which biocontrol prospects are low but where returns would be very high if biocontrol were to succeed. These categorisations are based on the best available information, but changes should be expected as more information becomes available. For example, biocontrol may still fail for taxa assessed to have high biocontrol prospects based on overseas successes, and break-throughs are possible even with taxa where biocontrol prospects are currently considered to be low. Potential impact had a strong bearing on which taxa were shortlisted. Better quantification of potential impact for some taxa therefore justifies research in its own right prior to significant resources being invested on biocontrol.

The purpose of this project was to provide the best available information for funding agencies responsible for RD&E for livestock industries to make investment decisions. It is expected that the optimal biocontrol investment portfolio would include a balance of weeds that may not be as serious for the industry, but where benefits will be achieved through relatively limited investment, and more serious weeds requiring long-term investment associated with higher risks, but for which if successful biocontrol would generate major benefits.

The approach taken in this project could be readily adapted to other sectors, simply by adjusting the definitions for current and potential impacts. It would provide a mechanism for guiding co-investment decisions for the many cross-sectoral weeds, thereby providing the basis for maintaining and directing a strong, vibrant and effective weed biocontrol capability in Australia.

Acknowledgement

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1 Background

Weeds affect livestock industries in Australia in many ways. Livestock production is reduced as weeds replace more desirable pasture species resulting in less feed. Toxic weeds can directly affect animal health. Weed residues can contaminate produce (e.g. seeds in wool), which is then discounted. Weeds can restrict livestock movement and access to water and affect overall farm operations. The financial impact (yield losses and costs of control) of weeds on livestock industries in Australia was estimated to be more than $2 billion a year in the early 2000s (Sinden *et al.* 2004).

Classical biological control (biocontrol) is the only realistic option for managing many of the serious weeds affecting livestock industries in Australia. This approach involves the deliberate introduction of host-specific natural enemies of the target weed from the native range into the region where the plant has become a problem (Briese 2000). The advantage of biocontrol is that, once natural enemies (agents) are widely established, they exist permanently in the ecosystem and are mostly self disseminating. Biocontrol can suppress weeds to the point that they no longer cause significant impacts. More often it complements rather than replaces other management techniques. For example, within a pastoral context biocontrol can make it more feasible to manage weeds through grazing management and physical and chemical control.

The livestock industries have had a long history of investment in weed biocontrol in both northern and southern Australia. For example, the Australian meat and wool industries invested for many years in the biocontrol programs for Paterson's curse (*Echium plantagineum*) and Onopordum thistles (*Onopordum* spp.), in addition to in-kind contributions from the CSIRO, the NSW, Victorian, South Australian and Western Australian state departments, and the Weed CRC (Briese 2012, Sheppard and Smyth 2012). These programs were highly successful at establishing effective redistribution networks for the released biocontrol agents within each state. Three of the six released agents that established on Paterson's curse – the root crown weevil, the taproot weevil and the flea beetle – have been collectively responsible for the widespread decline in the abundance of the weed (Sheppard and Smyth 2012). Two of the four released agents that established on Onopordum thistles – the seed weevil and the stem-boring weevil – are making substantial measurable reductions to seed production and plant vigour (Briese 2012).

Biocontrol programs are typically long-term and costly. Therefore it is critical that weed targets are carefully selected by assessing them against likely return on investment in biocontrol. However, little attention has been given to developing sound processes for target selection for biocontrol. For example, the relative importance of a particular weed problem, and how feasible and realistic biocontrol is as a management option for that species, are not generally explicitly considered when prioritising weed targets for biocontrol.

The few previous attempts to prioritise weed targets for biocontrol have relied on point scoring systems that variously factor in attributes relating to the impact of the weed and, feasibility and likelihood of success of biological control (e.g. McClay 1989; Peshken and McClay 1995; Palmer and Miller 1996; Paynter *et al.* 2009; Lefoe and Ainsworth 2012). Point scoring systems have been used with some success in other applications, for example in the Australian Weed Risk Assessment (WRA) system, where the objective is to minimise the risk of importing plant species that have a high likelihood of becoming weeds (Pheloung *et al.* 1999). The WRA approach however, is not without its critics because of its high level of uncertainty and inaccuracy, as well as the potential cognitive biases of assessors (Hulme 2012; Smith *et al.* 1999; Caley *et al.* 2006).

The appropriateness of point scoring systems for prioritising weed targets for biocontrol has been questioned; especially where the objective is to comparatively assess a relatively small number of potential targets. A point scoring system depends on the variables included and how they are combined (e.g. additive, multiplicative) and weighted. Consequently the objectivity of the approach can be illusory. Further, the generation of scores can lead to the 'psychology of quantification' taking over, resulting in a false impression of certainty. These limitations probably contribute to developed point scoring systems not (to our knowledge) being used in practice to guide target prioritisation in weed biocontrol.

A transparent prioritisation process for weed biocontrol targets should achieve the right balance between targeting weeds of moderate to high impact on livestock industries where biocontrol agents with demonstrated efficacy elsewhere are readily available and have a high chance of being successful if released in a new environment, and high impact weeds where they may not be. It should also guide and focus research on key knowledge gaps preventing the adequate assessment of some weeds. Such an approach would provide the information required for agencies responsible for Research, Development and Extension (RD&E) for livestock industries, including MLA, to make reasoned, evidence-based investment decisions across their weed biocontrol portfolio.

2 Project objectives

2.1 Goal

The project's goal was to develop and apply a framework to prioritise classical biocontrol efforts using new agents for weeds relevant to livestock industries in Australia. The framework was to consider the importance of the weeds to livestock industries, the feasibility of undertaking a biocontrol program that would yield host-specific agents, and the likelihood that biocontrol agents would be successful in mitigating the impact of the weeds once released in Australia.

2.2 Objectives

The objectives of the project were:

1. Development of the process to be used for prioritisation of weed targets for biocontrol.
2. Assessment of the current and potential impacts of weeds identified in a concurrent project (Grice *et al.* in preparation) as priorities for RD&E to address weed problems of Australian livestock industries and formulation of explicit goal(s) for biocontrol.
3. Detailed assessment of at least 20 key weeds for biocontrol feasibility and likelihood of success.

3 Methodology

3.1 Development of prioritisation framework

The framework for prioritising weed biocontrol targets designed during this project is based on a matrix assessment system that has been extensively used in a range of situations (e.g. assessment of levels of risks and how and where to prioritise and apply risk management). It was devised to guide investments aimed at finding new classical biocontrol agents for weeds relevant to Australian livestock industries. Options to enhance the efficacy of already released biocontrol agents or to explore non-classical biocontrol approaches were considered separately from the prioritisation framework.

For each weed taxon, the prioritisation framework first involved categorising the current and potential impacts of the weed on livestock enterprises (Fig. 1 – Step 1). Information on impact on livestock enterprises were obtained from a range of sources, including web searches, consultations with on-ground weed officers, published literature (e.g. Parsons and Cuthbertson 2001 and unpublished research and observations of team members and others). A specific ranking was assigned to the weed, according to strict definitions (Appendix 1), and was supported with a written rationale that explained the ranking assigned and captured any uncertainties or qualifications in the ranking. For potential impact assessments, a range of rankings was also included to capture uncertainty. Weeds whose current and potential impacts were assessed as being negligible were not processed further through the prioritisation framework. For each of the other weeds, the primary goal(s) of their specific biocontrol programs were devised (Fig. 1 – Step 2, Appendix 2).

The prioritisation framework next involved categorising the feasibility of undertaking a biocontrol program for that specific weed (Fig. 1 – Step 3), according to defined categories and guidelines (Appendix 3). Feasibility of biocontrol referred to the capability of establishing a biocontrol program for the weed taxon (amount of effort) and chances of discovering host-specific agents. It included an assessment of the constraints and opportunities considering a range of social/political, logistical and ecological attributes. Weeds for which a biocontrol program was deemed unfeasible were not processed further through the prioritisation framework.

For all other weeds, the likelihood that biocontrol agents would be successful in achieving the *a priori* goal(s) of the biocontrol program was then categorised (Fig. 1 – Step 4), according to defined categories and guidelines (Appendix 4). Based on available knowledge and assuming host-specific agents are available, this assessment considered whether there was a reasonable expectation that the agent(s) that will potentially be found will cause the right type, level and duration of damage to achieve the goal(s). Each of the biocontrol-related categorisations was also supported with a written rationale that explained the ranking selected, with any uncertainties and qualifications included.

The categorisations of biocontrol feasibility and likelihood of success were combined to generate a single ranking, supported by a summary explanation, that represents the prospects of biocontrol to mitigate the impact of the weed (Fig. 1 – Step 5, Fig. 2) (e.g. low rank for feasibility and high rank for likelihood of success resulting in a moderate rank for biocontrol prospect; high rank for feasibility and moderate rank for likelihood of success resulting in a moderate-high rank for biocontrol prospect). Key investment areas for future actions/research that specifically addressed biocontrol knowledge gaps for each weed were also identified.

The biocontrol prospects ranking and current and potential impact rankings were used to allocate the weed to a cell in each of the two matrices: ‘biocontrol prospects × current weed impact’ and ‘biocontrol prospects × potential weed impact’ (Fig. 1 – Step 6, Fig. 2).

3.2 Weed taxa processed

Seventy-nine weed taxa were assessed using the weed biocontrol target prioritisation framework (Appendix 5). These taxa were identified in a concurrent project, supported by MLA, as priorities for RD&E to address weed problems of Australian livestock industries (Grice *et al.* in preparation). All, but two, originated from the draft list of prominent weeds of that concurrent project. The two additional taxa processed, *Chromolaena odorata* and *Physalis viscosa*, were identified as emerging weed species in that project.

Fifty-eight of the weed taxa assessed with the prioritisation framework have received at least some attention as biocontrol targets in Australia or elsewhere. Some taxa were assessed as a group for biocontrol feasibility and likelihood of success as biocontrol experts decided there was little benefit from assessing them individually: e.g. slender thistles (*Carduus tenuiflorus* and *C. pycnocephalus*), mission grasses (*Cenchrus pedicellatus* and *C. polystachios*), Cape tulips (*Moraea flaccida* and *M. miniata*), and the *Opuntia* and *Cylindropuntia* spp., and *Sporobulus* spp. complexes.

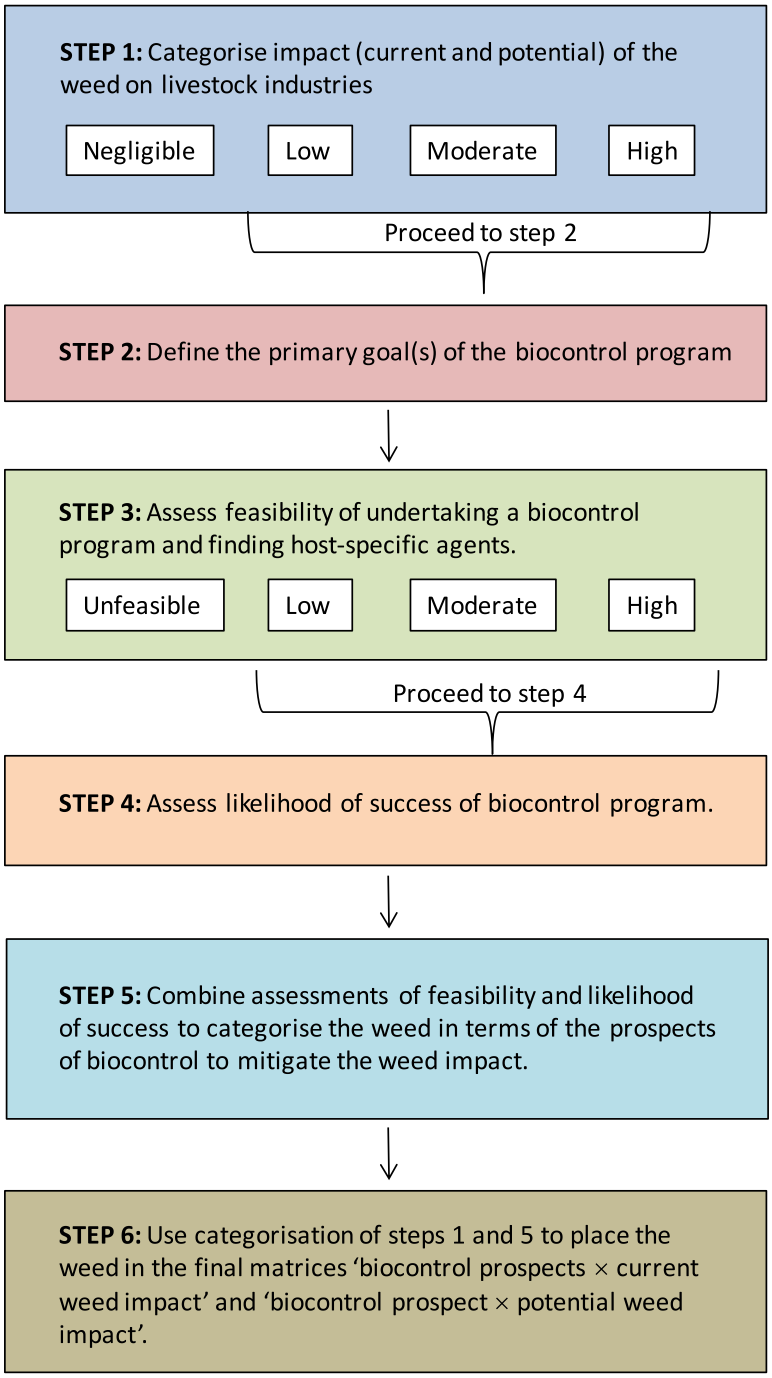

Figure 1. Schematic of the steps of the prioritisation framework developed to assess weed taxa relevant to livestock industries in Australia as target for classical biocontrol with new agents.

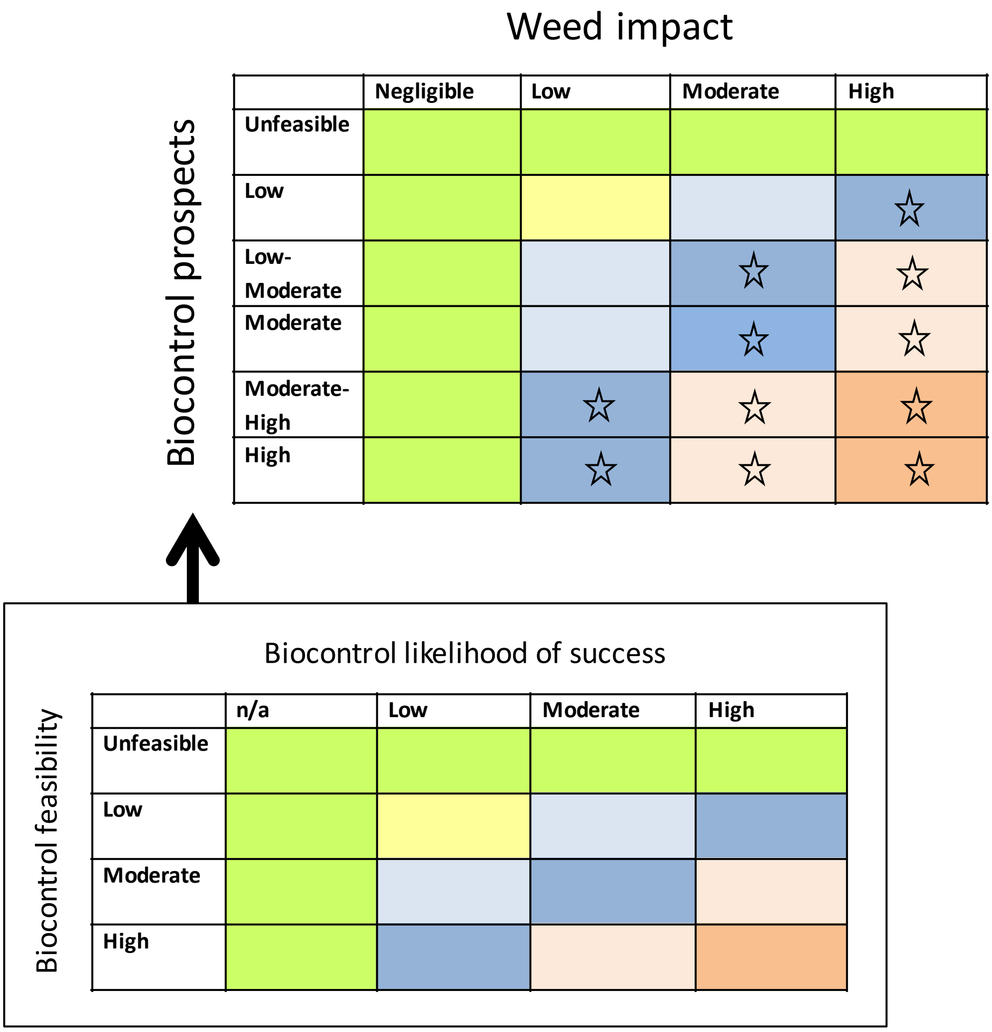

Figure 2. Schematic of the matrix assessment system that underpinned the prioritisation framework developed. The matrix ‘biocontrol feasibility × biocontrol likelihood of success’ is a prerequisite to categorise the prospects of biocontrol to mitigate the impact of the weed in the final matrices ‘biocontrol prospects × current weed impact’ and ‘biocontrol prospects × potential weed impact’**.** Weeds assigned to dark blue or, dark or light orange cells (indicated with stars) in the final matrices ‘biocontrol prospects × weed impact’ are considered priority taxa.

3.3 Expert elicitation

An expert elicitation and consultative approach was taken to gather the necessary information and opinions to process each weed through the prioritisation framework.

A two-day workshop was held to elicit knowledge from other Australian biocontrol practitioners and ecologists. These included representatives from SA, Tas, Vic, NSW and QLD with experience in biocontrol-related research and extension. The categorisation of weed impacts was determined by the project team and circulated to participants prior to the workshop for comments. Issues identified by participants were discussed and addressed at the beginning of the workshop.

Participants were split into two working groups (temperate and tropical) based on their general knowledge and experience, and the weeds to be assessed were allocated to the relevant groups. The weeds were then allocated to members within each group, based on their expertise. The 'tropical' group collectively assessed the appropriateness of the primary goals of each weed (devised by the project team before the workshop), while members of the 'temperate' group individually made this assessment on each weed allocated to them. Members of both groups individually recorded as much information as possible on each weed following guidelines provided for the assessments of biocontrol feasibility and likelihood of success (Appendices 3, 4).

Once the individual assessments were completed, each group reconvened, shared information/opinions on each weed and collectively decided on appropriate rankings to categorise biocontrol feasibility and likelihood of success for the weed using definitions provided (Appendices 3, 4). The group also discussed research activities that could be undertaken to change the rankings of biocontrol feasibility and/or likelihood of success, as well as options to enhance efficacy of already released biocontrol agents or to explore non-classical biocontrol approaches.

3.4 Compilation, cross-checking and iteration

All information gathered at the workshop was compiled into a single spreadsheet. The project team then: 1) checked/corrected information where required, 2) added information that was missing, 3) adjusted the primary goals for the biocontrol program following comments from workshop participants, 4) standardised categorisations for a number of weeds and, 5) summarised, reviewed or edited information into short rationale statements to support rankings for biocontrol feasibility, likelihood of success and biocontrol prospects, and possible investment areas for new and existing agents, and non-classical biocontrol approaches, where applicable.

The compiled information and rankings were circulated to workshop participants for additional comments, which were taken into consideration in finalising results.

3.5 Shortlisting of priority taxa for biocontrol

Weeds assigned in Figure 2 to dark blue or, dark or light orange cells, or indicated with stars, in either or both of the matrices comprising current or potential impact were shortlisted. These were considered priority weeds that agencies responsible for RD&E for livestock industries should consider for future investment. For example, to be shortlisted, weeds with low current and/or potential impacts had to have at least moderate-high biocontrol prospects, whereas high impact weeds were included even if biocontrol prospects were low-moderate.

4 Results

We report on key findings in this report and associated appendices. The extensive information on which assessment of each weed taxon was based is included in an Excel file provided to MLA with this final report *(refer toAppendix9). If a copy of the Excel spreadsheet is required please email Cameron Allan callan@mla.com.au*

4.1 Impact of weeds

The categorisation of current and potential impact of the weeds, based on definitions provided (Appendix 1), is presented in Figure 3. The rationales supporting each categorisation, together with a range of rankings for potential impact to capture uncertainty, are provided in Appendix 6.

The current impact of most weeds was ranked as negligible or low (Fig. 3). Only two taxa were ranked as having a high current impact, *Lantana camara* and *Vachellia nilotica* ssp. *indica* (syn *Acacia nilotica* ssp. *indica*).The potential impacts of 50 of the assessed weeds were ranked the same as current impact. Impact may still increase with time for these taxa, but best available information suggested it would not be sufficient to change rankings. The impacts of eighteen taxa are expected to increase from negligible or low to moderate with time, while impacts of two other taxa, *Prosopis* spp. and *Opuntia robusta*, are expected to increase to high. In contrast, the impact of four taxa (*Echium* plantagineum, *Hypericum perforatum*, *Senecio jacobaea*, *Onopordum* spp.) is expected to decrease with time as a result of ongoing damage by existing biocontrol agents. The current and potential impacts of 11 of the weeds were ranked as negligible, and these taxa were therefore not assessed further through the prioritisation framework (Fig.1 – Step 1).

4.2 Biocontrol with new agents

4.2.1 Primary goal(s) of biocontrol programs

A priori primary goal(s) for biocontrol were devised for each weed target (Appendix 7). The likelihood of success of biocontrol was subsequently assessed against these goals. These goals could ultimately be used in the future to evaluate the success of programs.

The biocontrol goals devised for a majority of weeds, especially those prevalent in temperate Australia, are to improve livestock carrying capacity by reducing weed density and competitive ability. For weeds that impact livestock industries in different ways, a range of additional goals were formulated, such as reducing hindrances caused by the weeds to farm operations and livestock movements, slowing spread to other areas and lessening the influence of the weed on grazing management strategies.

4.2.2 Biocontrol feasibility and likelihood of success

Detailed information gathered to assess biocontrol feasibility and likelihood of success for the weeds processed through the prioritisation framework can be found in the Excel file provided with this final report.

Both biocontrol feasibility and likelihood of success were categorised as low for more than half of the weeds assessed (Fig. 4, Appendix 8). In some instances, lack of available information or uncertainties, combined with experiences with comparable targets, were the reasons for the low rankings. In other instances, low rankings were assigned to weeds for which all known possible suitable biocontrol agents have already been released (e.g. *Carduus nutans*, *Echium plantagineum*, *Mimosa pigra*, *Onopordum* spp., *Senecio jacobaea*).

Biocontrol was assessed as unfeasible for *Eragrostis curvula*, *Hordeum* spp. and *Vulpia* spp. On the other hand, *Chromolaena odorata* was ranked high for both feasibility and likelihood of success of biocontrol, on the basis that agents, which have been successful in controlling the weed elsewhere, are readily available.

4.2.3 Prospects for biocontrol and key investment areas

For each assessed weed, irrespective of their current and potential impact rankings, the prospects for biocontrol were summarised into a single statement (based on assessments undertaken for biocontrol feasibility and likelihood of success) and key investment areas for future work identified (Appendix 7). The key investment areas outlined are actions that if undertaken could change (increase or decrease) rankings of biocontrol feasibility and/or likelihood of success.

Potential weed impact

Current weed impact	Negligible	Low	Moderate	High
Negligible	*Cenchrus longispinus* and *C. incertus* *Diplotaxis tenuifolia* *Erodium cicutarium* *Galium tricornutum* *Hypochaeris* spp. *Hyptis suaveolons* *Mimosa diplotricha* var. *diplotricha* *Rumex* spp. *Tamarix aphylla* *Tribulus terrestris*	*Cenchrus pedicellatus* and *C. polystachios* *Lantana montevidensis* *Senna obtusifolia* *Themeda quadrivalvis*	*Chromolaena odorata* *Cylindropuntia aurantica* *Cylindropuntia fulgida* *Cylindropuntia imbricata* *Cylindropuntia rosea* *Cylindropuntia tunicata* *Opuntia monocantha*	*Opuntia robusta*
Low	*Senecio jacobaea*	*Arctotheca calendula* *Asphodelus fistulosus* *Calotropis procera* *Carduus nutans* *Carthamus lanatus* *Cirsium arvense* *Harrisia martinii* *Hordeum* spp. *Marrubium vulgare* *Mimosa pigra* *Parkinsonia aculeata* *Raphanus raphanistrum* *Reseda lutea* *Rosa rubiginosa* *Vulpia* spp. *Xanthium occidentale* *Xanthium spinosum*	*Andropogon gayanus* *Bryophyllum delagoense* *Cytisus scoparius* *Emex australis* *Euphorbia terracina* *Hyparrhenia hirta* *Jatropha gossypiifolia* *Physalis viscosa* *Sporobolus africanus* *Sporobolus jacquemontii* *Ziziphus mauritiana*	*Prosopis* spp.
Moderate		*Echium plantagineum* *Hypericum perforatum* *Onopordum* spp.	*Carduus tenuiflorus* and *C. pycnocephalus* *Cirsium vulgare* *Cryptostegia grandiflora* *Eragrostis curvula* *Lycium ferocissimum* *Moraea flaccida* and *M. miniata* *Nassella neesiana* *Nassella trichotoma* *Parthenium hysterophorus* *Phyla canescens* *Romulea rosea* *Rubus fruticosus* agg. *Senecio madagascariensis* *Solanum elaeagnifolium* *Sporobolus fertilis* *Sporobolus natalensis* *Sporobolus pyramidalis* *Ulex europaeus*	
High				*Lantana camara* *Vachellia nilotica* ssp. *indica*

Figure 3. Weed taxa grouped according to current and potential impacts. Definitions for impact categories are provided in Appendix 1 and rationales for rankings in Appendix 6. Purple cells indicate taxa with the same current and potential impact. Turquoise cells indicate taxa whose impact are expected to decrease with time. Brown cells indicate taxa whose impacts are expected to increase with time.

Likelihood of success

Feasibility	n/a	Low	Moderate	High
Unfeasible	*Eragrostis curvula* *Hordeum* spp. *Vulpia* spp.			
Low		*Andropogon gayanus* *Carduus nutans* *Cenchrus pedicellatus* and *C. polystachios* *Cryptostegia grandiflora* *Cytisus scoparius* *Echium plantagineum* *Emex australis* *Harrisia martinii* *Hyparrhenia hirta* *Hypericum perforatum* *Mimosa pigra* *Nassella trichotoma* *Onopordum spp.* *Parkinsonia aculeata* *Parthenium hysterophorus* *Phyla canescens* *Raphanus raphanistrum* *Reseda lutea* *Rosa rubiginosa* *Rubus fruticosus* agg. *Senecio jacobaea* *Senecio madagascariensis* *Senna obtusifolia* *Sporobulus spp.* *Themeda quadrivalvis* *Ulex europaeus* *Xanthium occidentale* *Xanthium spinosum*	*Arctotheca calendula* ***Bryophyllum delagoense*** *Carthamus lanatus* ***Jatropha gossypiifolia*** ***Physalis viscosa*** ***Romulea rosea*** ***Solanum elaeagnifolium***	***Carduus tenuiflorus*** **and** ***C. pycnocephalus***
Moderate		***Nassella neesiana*** ***Vachellia nilotica*** **ssp.** ***indica*** ***Ziziphus mauritiana***	*Asphodelus fistulosus* *Calotropis procera* ***Euphorbia terracina*** ***Lycium ferocissimum*** ***Moraea flaccida*** **and** ***M. miniata***	***Cirsium vulgare***
High		*Cirsium arvense* ***Lantana camara*** *Lantana montevidensis*	***Marrubium vulgare*** ***Opuntia*** **and** ***Cylindropuntia*** **spp.** ***Prosopis*** **spp.**	***Chromolaena odorata***

Figure 4. Weed taxa grouped according to biocontrol feasibility and likelihood of success. Definitions for categories are provided in Appendices 3 and 4, and rationales for rankings in Appendix 8. Names in bold correspond to shortlisted taxa (see section 4.2.4).

4.2.4 Shortlist of priority taxa for biocontrol

The matrices 'biocontrol prospects × current weed impact' (Fig. 5) and 'biocontrol prospects × potential weed impact' (Fig. 6) show the result for each weed of the prioritisation process. Twenty-one weeds with the highest combined rankings for biocontrol prospects and current and/or potential impact were shortlisted as priority taxa for future investment (Table 1) (names in bold in Figs 5 and 6).

The emerging weed *Chromolaena odorata*, for which impact on livestock industries is expected to increase considerably, now that it is no longer an eradication target, was ranked as having the highest prospects for biocontrol, because of demonstrated success elsewhere. This weed can thus be considered a 'low hanging fruit' in terms of investment, with few investment risks involved. In contrast, a gap analysis of previous work is recommended for the shortlisted weeds that have been extensively studied for biocontrol in the past (e.g. *Vachellia nilotica* ssp. *indica*, *Cirsium vulgare*, *Carduus tenuiflorus* and *C. pycnocephalus*, *Jatropha gossypiifolia*, *Lantana camara*, *Nassella neesiana*), prior to further investment aimed at finding new agents. *Lantana camara* was identified as having moderate prospects despite over 100 years of biocontrol effort resulting in limited success (Figs 5, 6). This was because feasibility of finding further host-specific insects is high, but likelihood of achieving success is low (Fig. 4).

New agents with great potential for biocontrol have already been identified or are expected to be found for the weed taxa with moderate-high prospects for biocontrol. Weeds among the shortlisted taxa that have never been targeted for biocontrol (*Euphorbia terracina*, *Lycium ferocissimum*, *Physalis viscosa*, *Romulea rosea*, and *Ziziphus mauritiana*) were either assessed as having a moderate or low-moderate prospects for biocontrol. These rankings may be altered once initial surveys in the native ranges of these taxa are carried out and inventories of potential biocontrol agents are assembled.

Current weed impact

Biocontrol prospects

	Negligible	Low	Moderate	High
Unfeasible		*Hordeum* spp. *Vulpia* spp.	*Eragrostis curvula*	
Low	*Cenchrus pedicellatus* and *C. polystachios* *Senna obtusifolia* *Themeda quadrivalvis*	*Andropogon gayanus* *Carduus nutans* *Cytisus scoparius* *Emex australis* *Harrisia martinii* *Hyparrhenia hirta* *Mimosa pigra* *Parkinsonia aculeata* *Raphanus raphanistrum* *Reseda lutea* *Rosa rubiginosa* *Senecio jacobaea* *Xanthium occidentale* *Xanthium spinosum*	*Cryptostegia grandiflora* *Echium plantagineum* *Hypericum perforatum* *Nassella trichotoma* *Onopordum* spp. *Parthenium hysterophorus* *Phyla canescens* *Rubus fruticosus* agg. *Senecio madagascariensis* *Sporobulus spp.* *Ulex europaeus*	
Low-Moderate		*Arctotheca calendula* ***Bryophyllum delagoense*** *Carthamus lanatus* ***Jatropha gossypiifolia*** ***Physalis viscosa*** ***Ziziphus mauritiana***	***Nassella neesiana*** ***Romulea rosea*** ***Solanum elaeagnifolium***	***Vachellia nilotica* ssp. *indica***
Moderate	*Lantana montevidensis*	*Asphodelus fistulosus* *Calotropis procera* *Cirsium arvense* ***Euphorbia terracina***	***Carduus tenuiflorus* and *C. pycnocephalus*** ***Lycium ferocissimum***	***Lantana camara***
Moderate-High		***Marrubium vulgare*** ***Opuntia* and *Cylindropuntia* spp.** ***Prosopis* spp.**	***Cirsium vulgare*** ***Moraea flaccida* and *M. miniata***	
High	***Chromolaena odorata***			

Figure 5. Weed taxa grouped according to biocontrol prospects and current weed impact. Definitions for impact categories are provided in Appendix 1 and rationales for rankings in Appendix 6. The categories for biocontrol prospects are a combination of categories for biocontrol feasibility and likelihood of success and summary explanations for prospects rankings are provided in Appendix 7. Names in bold correspond to shortlisted taxa (see section 4.2.4).

Potential weed impact

Biocontrol prospects

	Negligible	**Low**	**Moderate**	**High**
Unfeasible		*Hordeum* spp. *Vulpia* spp.	*Eragrostis curvula*	
Low	*Senecio jacobaea*	*Carduus nutans* *Cenchrus pedicellatus* and *C. polystachios* *Echium plantagineum* *Harrisia martinii* *Hypericum perforatum* *Mimosa pigra* *Onopordum* spp. *Parkinsonia aculeata* *Raphanus raphanistrum* *Reseda lutea* *Rosa rubiginosa* *Senna obtusifolia* *Themeda quadrivalvis* *Xanthium occidentale* *Xanthium spinosum*	*Andropogon gayanus* *Cryptostegia grandiflora* *Cytisus scoparius* *Emex australis* *Hyparrhenia hirta* *Nassella trichotoma* *Parthenium hysterophorus* *Phyla canescens* *Rubus fruticosus* agg. *Senecio madagascariensis* *Sporobulus* spp. *Ulex europaeus*	
Low-Moderate		*Arctotheca calendula* *Carthamus lanatus*	***Bryophyllum delagoense*** ***Jatropha gossypiifolia*** ***Nassella neesiana*** ***Physalis viscosa*** ***Romulea rosea*** ***Solanum elaeagnifolium*** ***Ziziphus mauritiana***	***Vachellia nilotica* ssp. *indica***
Moderate		*Asphodelus fistulosus* *Calotropis procera* *Cirsium arvense* *Lantana montevidensis*	***Carduus tenuiflorus* and *C. pycnocephalus*** ***Euphorbia terracina*** ***Lycium ferocissimum***	***Lantana camara***
Moderate-High		***Marrubium vulgare***	***Cirsium vulgare*** ***Moraea flaccida* and *M. miniata*** ***Opuntia* and *Cylindropuntia* spp.**	***Prosopis* spp.**
High			***Chromolaena odorata***	

Figure 6. Weed taxa grouped according to biocontrol prospects and potential weed impact. Definitions for impact categories are provided in Appendix 1 and rationales for rankings in Appendix 6. The categories for biocontrol prospects are a combination of categories for biocontrol feasibility and likelihood of success and summary explanations for prospects ranking are provided in Appendix 7. Names in bold correspond to shortlisted taxa (see section 4.2.4).

Table 1. Shortlisted 21 priority weed taxa for future investment in biocontrol with new agents, grouped by biocontrol prospects rankings, with key investment areas outlined. Letter in parentheses next to names indicates the region where the weed taxon is predominant; N = northern, S = southern, W= widespread (both southern and northern regions).

Weed taxa	Stage(s) in the biocontrol development continuum						Key investment area(s) *
	Nomination as target required	Never surveyed in native range	Host-specificity testing in progress or completed	Begin investigation of already identified potential agent(s)	Gap analysis of previous work	Identify new potential agent(s)	
High prospects							
Chromolaena odorata (N)			✓	✓			1. Determine and progress with the most promising agents from overseas (work is already underway).
Moderate-high prospects							
Cirsium vulgare (S)					✓	✓	1. Investigate the genetics of the weed to identify most appropriate areas of native range to survey to find a crown-root weevil that attack the form of *C. vulgare* presents in Australia.
Marrubium vulgare (S)				✓	✓	✓	1. Recollect and attempt again to establish colonies of the three potential agents identified during surveys so that host-specificity tests can be performed. 2. If insect agents proved too difficult to rear, consider undertaking additional surveys specifically for pathogens.
Moraea flaccida and *M. miniata* (S)				✓			1. Finalise identification of Australian genotypes and use these to source virulent rust strains for subsequent host-specificity testing.
Opuntia and *Cylindropuntia* spp. (W)				✓	✓	✓	1. Clarify the taxonomy of naturalised species in Australia, and prioritise them for biocontrol. 2. Synthesis and gap-analysis of past work, including identifying biocontrol taxa already present in Australia. 3. Consider assessing the identified races of *Cactoblastis* and *Dactylopius* (cochineal insects) against the Australian invasive taxa (in a matrix design) to identify those that will have greatest impact on the highest priority Opuntioid species.
Prosopis spp. (W)				✓	✓	✓	1. Confirm high feasibility through a gap analysis of previous work and more comprehensive survey. 2. Host testing of potential agents following careful prioritisation based on potential impact, including evaluation of South African work.
Moderate prospects							
Carduus tenuiflorus and *C. pycnocephalus* (S)					✓	✓	1. Perform gap analysis of previous surveys data to better assess chances of finding a host-specific rosette-feeding insect agent.
Euphorbia terracina (S)	✓	✓		✓		✓	1. Determine if there are sufficient data to support nomination as a

							biocontrol target; if so nominate. 2. Perform an initial survey, especially to find the rust pathogen so that testing on Australian accessions of the weed can be performed to determine if there are any genotype matching issues. 3. Perform preliminary testing on key native *Euphorbia* spp. to obtain an indication of host-specificity before embarking on a comprehensive host-specificity testing program.
Lantana camara (W)					✓	✓	1. Conduct comprehensive gap analysis of historical native-range surveying in the light of recent genetic studies, and evaluate the potential for locating potentially damaging agents. 2. Consider further survey work, based on the gap analysis, specifically focussed on potential agents that are most likely to result in biocontrol goals being met.
Lycium ferocissimum (S)	✓	✓		✓		✓	1. Nominate as a biocontrol target. 2. Perform an initial survey, especially to find the rust pathogen so that testing on Australian accessions of the weed can be performed to determine if there are any genotype matching issues. 3. Perform preliminary tests on the native *Lycium australe* to obtain a key indication of host-specificity before embarking on a comprehensive host-specificity testing program.
Low-moderate prospects							
Bryophyllum delagoense (N)			✓		✓	✓	1. Follow the two tested beetle species through the Biocontrol Act. This would require quantification of actual and potential impact of the target (and non-targets). 2. Critically assess past exploration/testing work to determine whether other options are available.
Jatropha gossypiifolia (N)			✓		✓	✓	1. Complete host-specificity testing of rust, and release if safe. 2. Targeted exploration of congeners outside of the weed native range in South America.
Nassella neesiana (S)				✓	✓		1. Consider comments received on application for release of *Uromyces pencanus* in Australia and undertake additional tests if necessary to support risk analysis (could wait to see how the rust establishes and spreads in New Zealand, where it has been approved for release, before investing in additional tests). 2. Re-assess previous research and decide if additional efforts are warranted to further explore *Puccinia nassellae* and *Puccinia graminella* for Chilean needle grass

							biocontrol in Australia.
Physalis viscosa (S)	✓	✓				✓	1. Determine if there are sufficient data to support nomination as a biocontrol target; if so nominate. 2. Perform genetic study to identify more precisely region of origin of Australian populations. 3. Perform an initial survey of insect and fungi natural enemies there.
Romulea rosea (S)	✓	✓		✓		✓	1. Determine if there are sufficient data to support nomination as a biocontrol target; if so nominate. 2. Perform an initial survey, especially to find the rust pathogen so that testing on Australian accessions of the weed can be performed to determine if there are any genotype matching issues. 3. Perform preliminary tests on ornamental *Gladiolus* spp. grown in Australia to obtain a key indication of host-specificity before embarking on a comprehensive host-specificity testing program.
Solanum elaeagnifolium (S)					✓	✓	1. Carry out additional surveys for natural enemies if the precise origin of Australian populations in the native range, which is currently being identified in an international genetic study, corresponds to regions that have never before been explored.
Vachellia nilotica ssp. *indica* (N)			✓		✓	✓	1. Finalise testing of 3 remaining potential insects, and follow through if expected to cause required impact and are safe. 2. Critically assess past exploration/testing work to determine whether other options are available.
Ziziphus mauritiana (N)	✓	✓				✓	1. Assess whether biocontrol is better than diligent targeting of large-seeding trees. 2. Assess potential for targeting biocontrol to reduce seed production.

[*] Key investment areas the same as those presented in Appendix 7 for these taxa.

4.3 Enhancing biocontrol of existing agents

Biocontrol agents have already been released (or are about to be released) for several important pastoral weeds, and a range of further investments could be made to enhance their impact across the regions where the weeds are a problem (Table 2). For agents that are very slow to spread naturally (e.g. gorse soft shoot moth, horehound clearwing moth, broom gall mite), investment in redistribution to non-contiguous areas where the agents are not present would ensure more livestock enterprises benefit from biocontrol. In some instances, all signs are that the agents released are having a substantial effect in reducing abundance of the weeds (e.g. *Echium plantagineum*, *Onopordum* spp., *Cryptostegia grandiflora*), although this has not been adequately quantified.

More generally, investing in impact assessment of released agents would facilitate the development of options for integration with other weed management tactics that would lead to enhanced overall efficacy of biocontrol. Any resulting recommendations would have to be communicated well to farmers to reap maximum benefits from such investment.

For a few weeds, there is scope to revisit agents that have been approved for release but failed to establish following initial attempts (Table 2). Reasons for failed establishment could be further tested and if surmountable the agents could be re-introduced. For example, finding and releasing one or more mite strains for *Hypericum perforatum*, which are better matched to the main form of the weed in Australia than the strain that was released in the past, could considerably enhance the impact of this agent.

Table 2. Possible investment area(s) to enhance impact of existing (released) biocontrol agents in Australia.

Weed taxa	Potential investment area(s)
Redistribution and/or impact assessment and enhancement through integrated weed management (IWM)	
Carduus nutans	Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.
Carduus tenuiflorus and *C. pycnocephalus*	Rust fungus has likely naturally spread to all suitable sites and redistribution is not necessary. Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.
Cirsium vulgare	Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.
Cryptostegia grandiflora	Evaluate/quantify the distribution and effectiveness of the two existing agents (a rust and a moth), to determine whether their impact can be increased through redistribution, e.g., around Rockhampton and in the Kimberley. Identify whether there is a need for new biocontrol agents.
Cytisus scoparius	Distribute *Aceria* mite agent, which is very slow to spread naturally, into non-contiguous areas where it is not present. Evaluate/quantify the impact of agents released (including the rust that was not an authorised release), assess if impact can be enhanced through IWM and develop recommendations for farmers.
Echium plantagineum	Assess existing data on impact of released agents and collect additional data if necessary. Assess if impact can be enhanced through IWM and/or further redistribution of agents and develop recommendations for farmers. Revisit initial economic analysis.
Harrisia martinii	Determine reason why biocontrol is apparently not as effective in southern Qld and northern NSW. Then identify whether the problem can be overcome, e.g., through additional releases.
Hypericum perforatum	Determine why the beetle *Agrilus hyperici* has so poorly established in Australia, and, if resolved, rear and distribute this agent in areas where other agents do not perform as well. Evaluate/quantify the impact of all agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.
Lantana camara	Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.
Lantana montevidensis	Could revisit past efforts. Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.
Marrubium vulgare	Distribute clearwing moth agent, which is very slow to spread naturally, into non-contiguous areas where it is not present. Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.
Mimosa pigra	Continue redistributing *Nesaecrepida infuscata* which is now established. Assess the large amounts of unpublished, semi-analysed post-release

	data to determine whether impacts of existing agents could be enhanced. Non-classical biocontrol: explore whether natural dieback phenomenon can be exploited.
Onopordum spp.	Determine compatibility of released strains of the crown weevil *Trichosirocalus brieseii* towards stemless Onopordum (*O. acaulon*) in SA and WA, and if compatible redistribute on this species. Evaluate/quantify the impact of agents released (including those on O. acaulon), assess if impact can be enhanced through IWM and develop recommendations for farmers.
Opuntia & *Cylindropuntia* spp.	Using genetic analyses determine what *Dactylopius* species we have in Australia, and their preferred hosts. Any re-releases may require retesting as these species were unintentionally left off the Federal Approved Release List for Biocontrol Agents. Evaluate/quantify the impact of selected agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.
Parkinsonia aculeata	Follow through on national release and redistribution of two existing agents (one approved, the other subject to approval). No further benefits are expected from previously released agents.
Parthenium hysterophorus	Assess the distribution of the most effective agents and, if required, distribute them into non-contiguous places (southern Qld). Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.
Senecio jacobaea	Develop extension activities targeting farmers to facilitate/enhance integration of biocontrol agents with other weed management methods.
Ulex europaeus	Distribute the most promising agent, soft shoot moth, which is slow to build up populations and spread, to areas of south-eastern Australia where it is not present. Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.
Xanthium occidentale (syn *X. strumarium*)	Survey southern USA for compatible strains of the rust fungus that already occurs in Australia, which could be better adapted to hot/dry climates. Existing insect agents have limited impact and the existing rust strain has reached it eco-climatic limits, therefore redistribution of those agents likely to have limited benefit.
Re-introduction of agents following failed establishment and/or limited impact with released biotypes	
Hypericum perforatum	Investigate the genetics of the weed to identify most appropriate areas of native range to collect more efficient strain(s) of the mite *Aculus hyperici*. It is most likely that there is a mis-match between the main form of the weed in Australia and the strain of the mite released because damage in Australia is far less severe than in the native range.
Jatropha gossypiifolia	Consider re-releasing the jewel bug with a broader genetic base to improve impact. The initial introduction was based on one importation that was bred in the laboratory for several years prior to release.
Lantana camara	Could potentially revisit the c 13 species that failed to establish. However, their potential to cause the required impact would need to be assessed and host-specificity confirmed for some species.
Mimosa pigra	Determine whether there is any value in reintroducing agents that failed to either establish or thrive.

4.4 Exploring non-classical biocontrol options

Options to explore naturally-occurring dieback or specific diseases that have been recorded in Australia, and in some cases already studied in detail (e.g. *Phomopsis* spp. on *Carthamus lanatus*, *Colletotrichum orbiculare* on *Xanthium spinosum*), were identified during the project (Table 3). Investment to further develop this area could be beneficial for livestock industries, especially if practical and cost-effective augmentative approaches could be developed and implemented. It is important however, to emphasise that commercial bioherbicides based on pathogens are unlikely to ever be a viable proposition, because the market potential of such products in Australia is too low to justify costs of development and registration.

Table 3. Possible investment area(s) in non-classical biocontrol approaches exploiting indigenous pathogens in Australia.

Weed taxa	**Potential investment area(s)**
Carthamus lanatus	Consider developing a non-commercial augmentative biocontrol approach to enhance the efficacy of the existing *Phomopsis* spp. pathogens that affect the weed, since the market potential for a commercial bioherbicide is too low to justify costs of development.
Cirsium arvense	Wait for results from New Zealand on options to enhance the efficacy of the rust fungus *Puccinia punctiformis* on this weed using an augmentative biocontrol approach. If promising, conduct trials in Australia.
Jatropha gossypiifolia	Explore whether natural dieback phenomenon can be exploited.
Mimosa pigra	Explore whether natural dieback phenomenon can be exploited.
Nassella trichotoma	Investigate soil pathogens suspected to regulate serrated tussock populations in Australia. These may be amenable to an augmentative biocontrol approach.
Parkinsonia aculeata	Explore whether natural dieback phenomenon can be exploited.
Raphanus raphanistrum	Consider developing a non-commercial augmentative biocontrol approach to enhance the efficacy of existing pathogens that affect the weed in Australia, especially *Hyaloperonospora parasitica*, which is genetically distinct to isolates found on *Brassica* spp. including canola.
Rubus fruticosus agg. (primarily *R. anglocandicans*)	A *Phytophthora* sp. has been linked with the extensive, naturally-occurring dieback of invasive blackberries observed in riparian areas in south-west WA (39 km of river bank affected). Consider developing a non-commercial augmentative biocontrol approach based on this pathogen to deploy in major infestations, since it is unlikely that there would be a market potential for a commercial bioherbicide.
Sporobulus spp.	Explore whether *Nigrospora oryzae*, which causes crown rot of *Sporobulus* spp., can be developed into a non-commercial augmentative biocontrol approach to deploy in major infestations, since it is unlikely that there would be a market potential for a commercial bioherbicide.
Ulex europaeus	Investigate the natural dieback that has recently been observed in Tas and assess if this could be exploited to enhance biocontrol.
Vachellia nilotica ssp. *indica*	Explore whether natural dieback phenomenon can be exploited.
Xanthium spinosum	Consider developing a non-commercial augmentative biocontrol approach to enhance the efficacy of the existing *Colletotrichum orbiculare* pathogen that affects the weed, since the market potential for a commercial bioherbicide is too low to justify costs of development.

5 Discussion

Weed management, including biocontrol, is ultimately aimed at reducing weed impacts. Therefore our prioritisation framework focussed on first identifying current and potential impacts of the weeds to livestock industries and using these assessments to develop explicit *a priori* goals for biocontrol programs. These goals served to help assess the likelihood of success of biocontrol and could ultimately be used to assess the success of biocontrol programs after they are implemented (e.g. a goal that involves slowing the spread of a hardy weed may be more easily achieved with biocontrol than one that requires removal of extensive infestations).

We embraced a relatively strict set of definitions to assess weed impacts. They were based on the effect weeds have at the livestock enterprise level or higher (regional and national scale). These definitions excluded taxa that can reach high densities, but not over a sufficient area to cause serious impacts, being considered high impact weeds. They also assumed enterprises were already relatively well-managed, thereby categorising many relatively widespread and common weeds that are symptoms of poor management as having a negligible or low impact. Only four taxa were assessed as having, or with potential to have, a high impact on livestock industries using these strict assessment criteria (*Lantana camara*, *Opuntia robusta*, *Prosopis spp.*, *Vachellia nilotica* ssp. *indica*). Approximately half of the remaining taxa were assessed as having a potential to cause moderate impact with time, even if current impacts were considered to be negligible or low. However, in most cases there was considerable uncertainty surrounding assessments of potential impact of these taxa. More quantitative data on the impact of weeds on livestock enterprises are necessary to improve the categorisation of current and potential impacts of the weeds assessed as part of this project.

The key advantage of the prioritisation framework we developed is its transparency. Explanations are provided to support rankings for current and potential impacts, biocontrol feasibility and likelihood of success, and overall biocontrol prospects for each weed taxon. These explanations were used to determine where, with further research, assessments of biocontrol prospects or in some instances potential weed impact, could be further improved. The shortcoming of the process is that it relied on expert solicitation, which has been found to be prone to a range of cognitive biases such as past experience, overconfidence, motivational bias, and lack of independence (Burgman 2005). Nonetheless, all categorisations made are explained and consequently can be modified if other information or expert opinions are deemed more appropriate.

The 21 weed taxa shortlisted as priorities for biocontrol with new agents were selected because they had the highest combined rankings for biocontrol prospects and current and/or potential impacts. Thus this shortlist includes relatively minor weeds where biocontrol prospects are good, as well as the most serious weeds for which biocontrol prospects are low but where returns would be very high if biocontrol were to succeed. These categorisations are based on the best available information, but changes should be expected as more information becomes available. For example, biocontrol may still fail for taxa assessed to have high biocontrol prospects based on overseas successes, and break-throughs are possible even with taxa where biocontrol prospects are currently considered to be low. This includes the 12 taxa where potential impact is expected to be moderate, but biocontrol prospects low. Similarly, our assessment of potential impact may change with further research, and field observations. Potential impact had a strong bearing on which taxa were shortlisted. Better quantification of potential impact for some taxa therefore justifies research in its own right prior to significant resources being invested on biocontrol.

The purpose of this project was to provide the best available information for funding agencies responsible for RD&E for livestock industries to make investment decisions. These agencies may want to consider circulating this report to a wide range of stakeholders to seek comments and additional relevant information. Biocontrol is typically costly, and long-term, but the benefits if successful are high. An economic impact assessment of Australian weed biocontrol programs in 2006 indicated an overall benefit cost ratio of 23:1 (Page and Lacey 2006). It is expected that the optimal biocontrol investment portfolio would include a balance of weeds that may not be as serious for the industry, but where benefits will be achieved through relatively limited investment, and more serious weeds requiring long-term investment associated with higher risks, but if successful would generate major benefits. Indeed, the 21 priority taxa represent the full spectrum, from weeds where the best action is simply to bring in agents that have already been effective overseas, to commencing entirely new biocontrol programs against relatively poorly studied weeds, to reviewing and revisiting weeds that have already been long-term biocontrol targets.

Although the focus of this project was specifically on prioritising weed targets for biocontrol with new agents, we did nonetheless identify other potential investment areas to enhance efficacy of existing agents. For some weed taxa relatively modest investment in existing agents might offer considerable benefits as most work has already been done on these agents. On the other hand, naturally-occurring dieback and specific diseases have been reported for several of the weeds that affect livestock industries, at least locally, offering potential for developing novel non-classical biocontrol options for these taxa. Some research is already underway or being proposed by various groups to investigate these options (e.g. Aghighi *et al.* 2012, Haque *et al.* 2012, Officer *et al.* 2012).

The approach we took for prioritising weed biocontrol targets for livestock industries involved the majority of biocontrol practitioners in Australia. As such it drew on most of the current biocontrol expertise available for these weeds. The approach, although radically different from past attempts, received strong support from the biocontrol community. This approach could be readily adapted to other sectors, simply by adjusting the definitions for current and potential impacts. It would provide a mechanism for guiding co-investment decisions for the many cross-sectoral weeds, thereby providing the basis for maintaining and directing a strong, vibrant and effective weed biocontrol capability in Australia.

6 Bibliography

Aghighi S, Fontanini L, Yeoh PB, Hardy GE, Burgess TI, Scott JK (2012) Blackberry decline: a major disease of *Rubus anglocandicans* in south-west Australia. In *Proceedings of the 18th Australasian Weeds* Conference, Eldershaw (Ed), pp. 146-149. Weed Society of Victoria Inc. Melbourne, Australia.

Briese DT (2000) Classical biological control. In *Australia Weed Management Systems*, Sindel BM (Ed.), pp. 161-192. R.G. and F.J. Richardson, Meredith, Australia.

Briese DT (2012) *Onopordum acanthium* L. – Scotch thistle; *Onopordum* Illyricum L. – Illyrian thistle. In: *Biological control of weeds in Australia 1960 to 2010*, Julien M, Cruttwell McFadyen R, Cullen JM (Eds), pp. 416-424. CSIRO Publishing, Collingwood, Australia.

Burgman M (2005) Risks and decisions for conservation and environmental management. Cambridge University Press, Cambridge, UK.

Caley P, Lonsdale WM, Pheloung PC (2006) Quantifying uncertainty in predictions of invasiveness, with emphasis on weed risk assessment. Biological Invasions 8: 1595-1604.

Grice T, Morin L, Scott JK, Liu S (in preparation) A review of recent weed research and management relevant to Australian livestock industries and proposals for future investments. Final Report for project B.WEE.0132, Meat and Livestock Australia, North Sydney, Australia.

Haque A, Galea V, Goulter K, Bissett A, van Klinken RD (2012) A preliminary investigation of prickly acacia dieback (*Acacia nilotica* ssp. *indica*). In *Proceedings of the 18th Australasian Weeds* Conference, Eldershaw (Ed), pp. 131-134. Weed Society of Victoria Inc. Melbourne, Australia.

Hulme PE (2012) Weed risk assessment: a way forward or a waste of time? Journal of Applied Ecology 49: 10-19.

Lefoe G, Ainsworth N (2012) Prioritising Victorian government investment into weed biocontrol. In *Proceedings of the 18th Australasian Weeds* Conference, Eldershaw (Ed), pp. 359-360. Weed Society of Victoria Inc. Melbourne, Australia.

McClay AS (1989) Selection of suitable target weeds for classical biological control in Alberta. AEC V89-R1. Alberta Environmental Centre, Vegreville, Alberta, Canada.

Officer D, Ramasamy S, Lawrie AC (2012) Effect of season on the efficacy of artificial inoculation of *Nigrospora oryzae* in *Sporobolus fertilis*. In *Proceedings of the 18th Australasian Weeds* Conference, Eldershaw (Ed), pp. 142-145. Weed Society of Victoria Inc. Melbourne, Australia.

Page AR, Lacey KL (2006) Economic impact assessment of Australian weed biological control. CRC for Australian Weed Management, Technical Series No. 10, Adelaide, Australia.

Palmer WA, Miller EN (1996) A method for prioritizing biological control projects. In *Proceedings of the IX International Symposium on Biological Control of Weeds*, Moran VC, Hoffmann JC (Eds), pp. 313-317. University of Cape Town, South Africa.

Parsons WT, Cuthbertson EG (2001) *Noxious weeds of Australia. 2nd edition*. CSIRO Publishing, Collingwood, Victoria, Australia.

Paynter Q, Hill R., Bellgard S, Dawson M (2009) Improving targeting of weed biological control projects in Australia. Land & Water Australia Project no. LRN004729. Landcare Research Contract Report LC0809/072. Landcare Research, New Zealand.

Peshken DP, McClay AS (1995) Picking the target – a revision of McClay's scoring system to determine the suitability of a weed for classical biological control. In *Proceedings of the VIII International Symposium on Biological Control of Weeds*, Delfosse ES, Scott RR (Eds), pp. 137-143. CSIRO Publishing, Melbourne, Australia.

Pheloung PC, Williams PA, Halloy SR (1999) A weed risk assessment model for use as a biosecurity tool evaluating plant introductions. Journal of Environmental Management 57: 239-251.

Sheppard AW, Smyth M (2012) *Echium plantagineum* L. – Paterson's curse. In: *Biological control of weeds in Australia 1960 to 2010*, Julien M, Cruttwell McFadyen R, Cullen JM (Eds), pp. 211-226. CSIRO Publishing, Collingwood, Australia.

Sinden J, Jones R, Hester S, Odom D, Kalisch C, James R, Cacho O (2004) The economic impact of weeds in Australia. Technical Series No 8. CRC for Australian Weed Management, Adelaide, Australia.

Smith CS, Lonsdale WM, Fortune J (1999) When to ignore advice: invasion predictions and decision theory. Biological Invasions 1: 89-96.

7 Appendices

7.1 Appendix 1

Definitions to categorise current and potential impact of the weed as part of the prioritisation framework.

Category	Impact of weed on grazing industries
Negligible	At worst a nuisance weed that doesn't significantly affect production or the management of an enterprise, and rarely requires specific targeted control effort.
Low	Weed can cause at least minor enterprise-level production losses, or alter the way enterprises are managed. If serious impacts occur they are localised in extent within an enterprise* or to a few properties nationally, are the result of extended periods of poor property management, and /or are readily and cost-effectively managed.
Moderate	Weed can result in serious enterprise-level production losses, or substantially alter the way enterprises are managed, even when enterprises are relatively well managed, but affects relatively few properties regionally, and/or is readily and cost-effectively managed using existing approaches.
High	Weed can result in serious enterprise-level production losses, or substantially alter the way enterprises are managed, even when enterprises are relatively well managed, across a broad geographic area. Not readily or cost-effectively managed using existing approaches.

* Where the weed affects the most productive parts of the landscape then it is limited in extent there.

7.2 Appendix 2

Guidelines to develop an explicit description of the primary goal(s) of the biocontrol for the weed against which the likelihood of success of biocontrol will be assessed.

Goal of biocontrol program	What would success look like?	What would biocontrol need to do to the weed?
Improve carrying livestock capacity	• Weed more palatable and/or accessible to livestock • Weed makes less of a contribution to pasture layer • Better quality pasture	• Modify growth habit and/or structure of the weed • Reduce weed population density • Reduce weed growth rate • Reduce weed competition weed for water, light and nutrients
Improve farm management operations	• Mustering not hampered by the weed • Access to watering points and other infrastructure not hampered by the weed • Grazing management not dictated/constrained by the weed • Enterprise less fire prone and thus less costs for fire prevention • Burning practices not constrained by the weed	• Reduce weed patch size • Reduce weed population density • Reduce weed biomass
Reduce the need and/or frequency of non-biocontrol weed management tactics	• Lower recruitment of the weed following removal of adult plants, thus less follow-up control required	• Reduce weed growth rate • Reduce sexual reproduction • Reduce seed rain
Slow the spread of the weed to other areas	• Lower occurrence of new infestations on affected farms • Lower occurrence of new infestations on other farms • Sparse and thus more easily controlled new infestations	• Reduce vegetative and/or sexual reproduction

7.3 Appendix 3

Definitions and guidelines to assess the feasibility of undertaking a biocontrol program for the weed as part of the prioritisation framework.

Definitions:

Feasibility of undertaking a biocontrol program: Capability of establishing a biocontrol program for the weed taxon (amount of effort) and chances of discovering host-specific agents. Includes an assessment of the constraints and opportunities considering a range of social/political, logistical and ecological attributes.

To determine appropriate category use guidelines on next page:

Category	Feasibility of undertaking a biocontrol program
Unfeasible*	Only unsurmountable obstacle(s) (e.g. native weed; major conflict of interest)
Low	Some or many obstacles and a limited indication that they can all be overcome.
Moderate	Some or many obstacles and a reasonable indication that they can all be overcome.
High	None or few obstacles that can be easily overcome.

* Taxa that are placed in this category are not further assessed.

Guidelines:

Examples of possible foreseen or existing obstacles to undertaking a biocontrol program.

Attribute	**Possible foreseen or existing obstacles**
Social or political	
Socioeconomic value of weed	*e.g. the weed is valued by a sector of society and conflict between interests of different stakeholders is most likely*
Nomination as target for biocontrol (if applicable)	*e.g. insufficient data available on impact to support nomination to AWC*
Investment opportunities	*e.g. perception that enough investment has been made on the weed already*
Logistical	
Native range	*e.g. access to and surveying in the native range difficult; difficulties to export candidate agents because of biodiversity convention*
Research infrastructure and collaborative links	*e.g. inexistent network of collaborators in native range; lack of engagement by on-ground stakeholders in the redistribution of existing agents;*
Ecological	
Weed origin	*e.g. weed is native to Australia; origin unknown or "diffuse" (e.g. through long history of utilisation)*
Knowledge of weed	*e.g. taxonomy of weed unresolved; genetic diversity of weed in Australia unknown; most vulnerable stage in lifecycle to regulate populations unknown;*
Relatedness of weed to non-target species in Australia	*e.g. closely-related to crop or native species; limited information on the phylogenetic placement of weed;*
Knowledge of natural enemies	*e.g. natural enemies of weed in Australia unknown; none or limited literature available worldwide;*
Richness and host-specificity of natural enemies in native range	*e.g. no previous surveys performed in native range; prior testing performed in other countries; few host-specific agents expected to be found (give reasons, e.g. already comprehensively surveyed, type of plant etc.);*

7.4 Appendix 4

Definitions and guidelines to assess the likelihood of success of a biocontrol program for the weed as part of the prioritisation framework.

Definitions:

Likelihood of success of biocontrol program: The chance that the biocontrol program will achieve its a *priori* defined goal(s) and hence contribute to mitigate the identified impacts of the weed taxon. In other words, is there a reasonable expectation that the agent(s) that could potentially be found will cause the right type, level and duration of damage to achieve the goal(s)? (based on available knowledge and assuming host-specific agents are available).

To determine appropriate category use guidelines on next page:

Category	**Likelihood of success of biocontrol**
Low	Based on available knowledge, there are valid reasons why potential new agent(s) may not achieve the stated goal(s) of the biocontrol program.
Moderate	Based on available knowledge, there are at least some valid reasons why potential new agent(s) may not achieve the stated goal(s) of the biocontrol program, but there are sufficient “qualifications” or unknowns to suggest that success is still possible.
High	Based on available knowledge, there is no reason why potential new agent(s) could not achieve the stated goal(s) of the biocontrol program.

Guidelines:

Examples of possible foreseen or existing reason why agent(s) could NOT achieve goal(s), based on available knowledge and assuming host-specific agents are available.

Attribute	**Possible foreseen or existing reasons why agent(s) could NOT achieve goal(s)**
Weed life cycle	*e.g. population of the agent(s) may not be sustained over time because the weed is annual and ephemeral;*
Type, severity and duration of damage	*e.g. a very large reduction in weed growth rates/reproduction sustained over many years will be required; most seeds (> 99%) will have to abort or be destroyed to affect weed population; based on biocontrol programs in other country(ies) on the target weed or functionally similar species, there is no precedence to believe that the required damage will be achieved;*
Synchronisation of damage with weed life cycle	*e.g. weed inflorescence is produced early in the growing season and it is unlikely that agent(s) will be capable of eliminating seed production;*
Sensitiveness of weed to damage	*e.g. the weed has an extensive root system and is expected to be able to readily recover from damage unless it is very severe and sustained over many years;*
Habitat	*e.g. the weed occurs over a wide range of habitats, which means that agent(s) densities and thus efficacy will be more variable; the weed grows in low fertility soil and will have poor nutritional value for herbivorous insects;*
Climate	*e.g. the climate of the introduced range is very different to that of the native range where the agent(s) was/would be sourced; the weed occurs over a wide range of climatic zones, which means that agent(s) densities and thus efficacy will be more variable;*
Parasitism and/or predation of agents	*e.g. agent(s) that could achieve the required damage are known to be highly vulnerable to predation;*

7.5 Appendix 5

Weed taxa assessed through the prioritisation framework. These taxa were identified in a concurrent project, supported by MLA, as priorities for RD&E to address weed problems of Australian livestock industries (Grice *et al.* in preparation). Note that *Sporobulus* spp. and *Opuntia* and *Cylindropuntia* spp. were assessed separately for impacts and as a group for biocontrol feasibility and likelihood of success.

Weed taxa	Common name	Climate zone
Andropogon gayanus *	Gamba grass	N
Arctotheca calendula	Capeweed	S
Asphodelus fistulosus	Onion weed	S
Bryophyllum delagoense	Mother of Millions	N
Calotropis procera *	Calotrope	N
Carduus nutans	Nodding thistle	S
Carduus tenuiflorus and *C. pycnocephalus*	Slender thistles	S
Carthamus lanatus	Saffron thistle	S
Cenchrus longispinus and *C. incertus* *	Innocent weed	S
Cenchrus pedicellatus and *C. polystachios* *	Annual / perennial mission grasses	N
Chromolaena odorata †	Siam weed	N
Cirsium arvense	Californian thistle	S
Cirsium vulgare	Spear thistle	S
Cryptostegia grandiflora	Rubber vine	N
Cytisus scoparius	Broom	S
Diplotaxis tenuifolia *	Lincoln weed	S
Echium plantagineum	Paterson's curse	S
Emex australis	Spiny emex	S
Eragrostis curvula *	African love grass	S
Erodium cicutarium *	Common storksbill	S
Euphorbia terracina *	False caper	S
Galium tricornutum *	Three-horned bedstraw	S
Harrisia martinii	Harrisia cactus	N
Hordeum spp. *	Barley grass	S
Hyparrhenia hirta *	Coolatai grass	S
Hypericum perforatum	St. John's wort	S
Hypochaeris spp. *	Cat's ear	S
Hyptis suaveolons	Hyptis	N
Jatropha gossypiifolia	Bellyache bush	N
Lantana camara	Lantana	W
Lantana montevidensis	Creeping lantana	N
Lycium ferocissimum *	African boxthorn	S
Marrubium vulgare	Horehound	S
Mimosa diplotricha var. *diplotricha* (syn. *Mimosa invisa*)	Creeping sensitive plant	N
Mimosa pigra	Mimosa; Giant sensitive plant	N
Moraea flaccida and *M. miniata*	one and two-leaf Cape tulips	S
Nassella neesiana	Chilean needle grass	S
Nassella trichotoma	Serrated tussock	S
Onopordum spp.	Onopordum thistles	S
Opuntia & *Cylindropuntia* spp.; including *Cylindropuntia rosea* * *Cylindropuntia tunicata* *Cylindropuntia fulgida* * *Cylindropuntia imbricata* *Cylindropuntia aurantica* *Opuntia monocantha* *Opuntia robusta* *	Opuntioid cacti (as a group) Hudson pear Hudson pear Coral cactus Devils rope Tiger pear smooth tree pear, drooping prickly pear Wheel cactus	W
Parkinsonia aculeata	Parkinsonia	W
Parthenium hysterophorus	Parthenium weed	N
Phyla canescens	Lippia	S
Physalis viscosa *, †	Prairie ground cherry	S
Prosopis spp.	Mesquite	W
Raphanus raphanistrum	Wild radish	S
Reseda lutea	Cutleaf mignonette	S
Romulea rosea *	Guildford grass (=onion grass)	S
Rosa rubiginosa	Sweet briar	S
Rubus fruticosus agg. (primarily *R. anglocandicans*)	Blackberry	W
Rumex spp.	Dock	S
Senecio jacobaea	Ragwort	S
Senecio madagascariensis	Fireweed	S
Senna obtusifolia	Sicklepod	N
Solanum elaeagnifolium	Silverleaf nightshade	S
Sporobulus spp.; including *Sporobolus africanus* *Sporobolus fertilis* (syn *S. indicus* var. *major*) *Sporobolus jacquemontii* *Sporobolus natalensis* *Sporobolus pyramidalis*	Weedy sporobulus grasses (as a group) Parramatta grass Giant Parramatta grass American rat's tail grass Giant rat's tail grass Giant rat's tail grass	W W W N W W
Tamarix aphylla	Athel pine	W
Themeda quadrivalvis *	Grader grass	N
Tribulus terrestris	Caltrop	W
Ulex europaeus	Gorse	S
Vachellia nilotica ssp. *indica* (syn. *Acacia nilotica* ssp. *indica*)	Prickly acacia	N
Vulpia spp.	Vulpia or silvergrass	S
Xanthium occidentale (syn *X. strumarium*)	Noogoora burr	W
Xanthium spinosum	Bathurst burr	W
Ziziphus mauritiana *	Chinee apple	N

* Taxa that have never been the focus of research to develop and/or implement a biocontrol program in Australia or elsewhere.

† Taxa identified as emerging in Grice *et al.* (in preparation).

7.6 Appendix 6

Current and potential impacts of the weeds assessed through the prioritisation framework.

Weed taxa	Current impact	Current impact rationale	Potential impact	Potential impact range	Potential impact rationale
Andropogon gayanus	Low	It can form extensive monocultures in major soil types/habitats across the savannas. It was introduced and promoted as a pasture grass and can be beneficial in limited well-managed situations. However, it is not palatable once tall, potentially reducing carrying capacities. More importantly, high, late-curing biomass can result in increased numbers of extreme and catastrophic fire danger days. Extreme fires can pose serious threats to pastoral enterprises, and can greatly alter fire management options. Most serious impacts are still restricted, including in relatively small pastoral properties around Batchelor, NT.	Mod	Low-High	It has the potential to become dense across much of the higher-rainfall savannas, including in well-managed grasslands and woodlands. Increased fire risks from rank, high-biomass grass are expected to cause challenges for managing pastoral properties. It may also reduce pasture potential, although that has not yet quantified.
Arctotheca calendula	Low	Very widespread, mostly in temperate and sub-tropical regions, and sometimes dominant in pasture, especially in south west WA. Palatable to stock and has good similar crude protein and carbohydrate to clovers and grasses from autumn to spring. Nitrate poisoning of stock is possible though. Often predominant around stock camps. Can grow quickly in warm weather and displace sown pasture species. Spray grazing, spray topping and pasture topping can be used to keep levels low but are detrimental to subclover pasture.	Low	Low-Mod	Already very widespread so not expected to change except is localised areas, e.g. in Tas, Riverina Region NSW. Stolon forming populations in eastern States need investigation because of perception of increasing impact. However, overall impact on enterprises unlikely to change, unless subjected to extended period of poor management or severe drought.
Asphodelus fistulosus	Low	Widespread in semi-arid to subhumid warm-temperate regions. Generally associated with overgrazed pastures; does not dominate in well maintained pastures. Once established it is quite drought-hardy. It can grow very thickly and reduce other vegetation. Not palatable to stock.	Low	Low-Mod	Providing adequate pasture management is undertaken, enterprise-level production losses are not likely to increase.
Bryophyllum delagoense	Low	Causes poisoning if sufficient is eaten by naïve livestock. Can have serious implications for managing stock within properties (the loss of up to 140 head of cattle has been reported), and for movement/sale of naïve stock into infested areas. Widespread in throughout QLD, including Western Downs and Ipswich hinterland where it can be problematic. Becoming more	Mod	Neg-Mod	Anecdotal observations suggest is it is becoming more widespread and abundant.

		widespread in NSW where it is problematic around Moree and Narrabri. Typically has restricted distributions within properties, favouring high disturbance areas such as roadsides and creek lines. It is unclear whether it is an inconvenience to some, or a much more serious and widespread problem than that. Ranked as low, but could be actually be moderate, especially if stock losses are under-reported.			
Calotropis procera	Low	It is widespread across the savannas, but is a poor competitor, generally only becoming dense under high disturbance such as around watering points and following scrub-clearing. As a consequence dense infestations within properties are of limited extent. An exclosure study in the VRD also suggests dense populations can naturally decline. It is not thorny or toxic, and can be a browsed under some circumstances.	Low	Low-Mod	It is expected to continue to increase in extent and density under high disturbance conditions. The key questions are whether extensive, dense populations can form even across well-managed properties, and the longevity of infestations once formed.
Carduus nutans	Low	More restricted distribution than other *Carduus* spp. thistles. Can cause some production losses but infestations are generally localised in extent within enterprises (e.g. high nutrient and disturbed sites such as sheep camps and around stock yards). Occurs irregularly from year to year. Biocontrol program has been very effective against it.	Low	Low-Mod	Impact will continue to vary from years to years. Providing disturbance is kept to a minimum and pastures are well managed there should not be an increase in enterprise-level production losses. Its importance/relevant for grazing enterprises will be significantly reduced as biocontrol continues to be successful across the weed range.
Carduus tenuiflorus and *C. pycnocephalus*	Mod	Widespread in subhumid warm temperate regions. Weeds of improved pastures (following disturbance) and neglected areas. Can cause some production losses but infestations are generally localised in extent within enterprises (e.g. high nutrient and disturbed sites such as sheep camps and around stock yards). Occurs irregularly from year to year. Not readily grazed by stock because of spines. Heavy grazing encourages infestation. Requires a management plan persisting over a number of years. Biocontrol program has been very effective against *C. nutans*.	Mod	Low-Mod	Impact will continue to vary from years to years. Providing disturbance is kept to a minimum and pastures are well managed there should not be an increase in enterprise-level production losses.
Carthamus lanatus	Low	Very widespread in warm-temperate and sub-tropical semi-arid areas. Found in poor pastures but rarely in perennial or improved annual pastures because it doesn't withstand competition. Generally doesn't cause major production losses to well-managed livestock enterprises. Eaten when very young but has little fodder	Low	Low-Mod	Very widespread – has most likely reached all suitable habitats. More frequent droughts could exacerbate its impact on enterprises, but still it is unlikely to cause major problems beyond localised areas within enterprises.

		value. Dense patches can restrict stock movement. Also causes vegetable fault in wool. Heavy grazing encourages infestations. An effective control program combines cropping and pasture establishment. Spray-graze technique is effective for control.			
Cenchrus longispinus and *C. incertus*	Neg	Mainly found in the east in temperate subhumid and semi arid regions. Does not establish readily in pastures. Palatable to stock. Burrs are the main problem; they become badly tangled in wool, lowering its value and making sheep difficult to handle. No evidence of enterprise-level impacts. Preventing seeding is the key to successful control. This can be achieved with heavy sheep grazing in infested area.	Neg	Neg-Low	Unlikely to change, unlike increase in land use for wool production.
Cenchrus pedicellatus and *C. polystachios*	Neg	Ranked as high impact environment weed as it can invade natural bushland resulting in continuous cover beneath an intact canopy. It is unpalatable. However, no examples were found of it causing serious impacts in pastoral settings, certainly not at enterprise level.	Low	Neg-High	It is still early in its invasion. Further work is required to assess risks, for example to determine how competitive it is in pastoral systems.
Chromolaena odorata	Neg	An unpalatable herb which is expected to compete with pastures. Eradication program only recently abandoned. Current populations still too small and few to impact production.	Mod	Neg-High	Expected to have the ability to form monocultures, at least across the high-rainfall savannas. It benefits from high disturbance. Yet to be seen how competitive it will be in well managed pastoral settings, and what its soil/moisture requirements (and therefore "ecological reach") will be.
Cirsium arvense	Low	Restricted distribution, primarily in Vic and Tas. Confined to areas receiving more than 700mm annual rainfall and more a weed of crops than pastures. Seedling survival is poor, but once established it strongly competes with pasture and control can be difficult. Extensive and vigorous root system. Avoided by stock.	Low	Low	Impact on enterprises unlikely to change. Has probably reached all suitable habitats and further expansion in distribution unlikely under current climate.
Cirsium vulgare	Mod	Widespread in sub-humid cool-temperate regions. Readily establishes in highly fertile soil that are bare at the end of summer (commonly occurs in annual pastures but also in overgrazed or disturbed perennial pastures). Infestations are generally localised in extent within enterprises (e.g. high nutrient and disturbed sites such as sheep camps and around stock yards). Not readily grazed by stock. Spiny nature of plants deters animals from grazing pasture in their vicinity. Large patches are impenetrable to stock. Infestations promoted in heavily grazed pastures. Levels of	Mod	Low-Mod	Already quite widespread – has most likely reached all suitable habitats and impacts expected to remain the same.

		infestation vary from year to year. Contributes to vegetable fault of wool. Establishment of a perennial pasture is the recommended approach to control infestations.			
Cryptostegia grandiflora	Mod	Unpalatable. It is largely restricted to riparian zones in central-north QLD. It is ranked as moderate as it forms extensive infestations in the most productive parts of many properties in central-northern QLD. However, actual, proportional enterprise-level production losses need to be better quantified to confirm this. It is not thorny or toxic. Biological control is currently partially successful.	Mod	Low-High	It has the potential to further increase its distribution, including into riparian areas in the NT and the Kimberley region of WA. However, it is still unclear how well it will perform there, and how effective existing biocontrol will be. Also, the long-term impact of the existing pathogen in C-N QLD is still to be determined: have all impacts already occurred, or will rubber vine populations continue to decline?
Cytisus scoparius	Low	Distributed in Moderate to high rainfall areas of humid temperate regions (especially Vic and Tas). Primarily a weed of bushland and Neglected areas. Does not establish in improved pastures unless there are bare patches. Once established dominates vegetation. Only a localised problem for grazing industry, where it can cause some production losses. Control generally relies on cut stump method and spot spraying. Biocontrol has so far been ineffective.	Mod	Low-Mod	Likely to continue to spread. Could become worse as grazing is pushed out of the high rainfall zone into more native systems, e.g. invaded uplands and hilly areas in Vic, Tas and SA.
Diplotaxis tenuifolia	Neg	Distributed in warm-temperate regions of southern Australia (mainly Vic and SA). Invades poor pastures and becomes dominant, but doesn't cause problems in established, well-managed pastures. Considered by some as being valuable as fodder (formerly sown as pasture species). Grazed when in flower, otherwise it is ignored by stock. Introduction of perennial pasture species helps with its management.	Neg	Neg-Low	May potentially spread further and establish new infestations, especially in marginal land where it is difficult to maintain vigorous pastures.
Echium plantagineum	Mod	Very widespread in warm-temperate regions. Common weed of degraded pastures. Palatable to stock, especially sheep, prior to flowering. Contains toxins, but sheep, cattle and goats are least affected. The large, broad rosette leaves shade and smother most other species. It can cause potentially serious enterprise-level production losses, but generally not in all enterprises in all years across the broad geographical range of the weed. Sheep grazing at high stocking rates reduce the weed significantly. In contrast, it flourishes where only cattle are grazed. Spray/graze technique has proved effective for control. Biological	Low	Low-Mod	Impact on enterprises may be lessen if biocontrol continue to be effective and expands into new areas.

		control has shown promising signs but the agents have not yet reached high densities across the entire range of the weed to claim success.			
Emex australis	Low	Widespread in subhumid and semi-arid tropical, subtropical and temperate regions. Competes with pastures because it is fast growing and its prostrate growth smothers desirable species. Not readily eaten by stock (but poisoning of sheep has been reported). Can cause some production losses to grazing enterprises. Mainly a weed of crop-pasture rotations and tends to decline in permanent pastures. To be successful, control programs must aim at killing plants shortly after emergence and must be continued for several years.	Mod	Low-High	Likely to increase in importance with move back to pasture crop rotations.
Eragrostis curvula	Mod	Widespread in semi-arid subtropical grasslands. Highly persistent, summer-growing. Without intensive management can reduce the value of pasture. Often dominate sparse, overgrazed pastures. Palatable when young, but generally ignored by stock because many other more palatable species are available in spring-early summer. Quickly loses palatability (with exception of the Consol variety, or unless carefully managed). Can be maintained in an acceptable stage by topdressing (especially N) and heavy rotational grazing. Dominance can result in reducing carrying capacity by at least 3-4 DSE. Many landholders in northern and southern Tablelands and south coast consider it to be a serious weed affecting grazing enterprises in the 1980s and it is assumed to have continued on this trajectory.	Mod	Mod-High	Little data or direct observation to support projections. Better understanding is required regarding conditions required for it become dominant, and how extensive dominant infestations could become
Erodium cicutarium	Neg	Widespread throughout temperate and Mediterranean pastures of Australia, primarily on sandy soils. May prevent establishment of perennial grasses by blocking access to light. Palatable fodder that is useful in winter and spring and therefore not considered to significantly affect enterprise production and management. However, seeds can injure stock, shearers and handlers. Can be controlled with spray-grazing, pasture manipulation and spray topping.	Neg	Neg	May be more beneficial forage under drier climates.
Euphorbia terracina	Low	Most abundant in coastal and inland SA and in coastal sand dunes and pastures on calcareous soils of WA, from Geraldton to south of Fremantle. Considered both an environmental and pasture weed. Toxic to stock, but generally not eaten because of its acrid milky sap. Can	Mod	Low-Mod	Based on current distribution in SA, it has the potential to spread further into inland areas in WA, Vic and NSW. Could become an increasing problem for grazing industries in these states as number and density of

		be a serious competitor with pasture plants and can dominate pastures on calcareous soils e.g. Greenough region in WA.			infestations increase.
Galium tricornutum	Neg	Only localised/small infestations in SA and NSW. Present in only five farms in WA and is an eradication target. Problem in crop-pasture rotation situation because it is competitive, has a persistent seed bank and is particularly difficult to control in crops. Seed can be spread as a contaminant of agricultural products.	Neg	Neg	May increase in importance with move back to pasture crop rotations.
Harrisia martinii	Low	Based on anecdotal evidence that it is emerging as a relatively serious problem around Goondiwindi, NSW.	Low	Neg-Mod	Uncertainty regarding apparently emerging problem around Goondiwindi, NSW and the potential ability of existing biocontrol agents in managing it.
Hordeum spp.	Low	Very widespread in temperate and sub-tropical regions. Valuable fodder for early season production but avoided by stock when flowering. Seeds can cause injuries to stock and contaminate wool. Typically localised within enterprises, i.e. often associated with increasing soil fertility and can be seen in animal camp areas. Continuous grazing reduces perennial grasses and favours it, while more grazing reduces it in annual pasture systems. Any activity to stop seed set will provide good control of this weed.	Low	Neg-Low	Little data or direct observation to support projections. Better understanding is required regarding conditions required for it become dominant, and how extensive dominant infestations could become.
Hyparrhenia hirta	Low	Locally dominant on road sides on the north western slopes of NSW and adjacent areas of QLD. Only a few other infestations across the country. Mainly a roadside and bushland weed of increasing frequency in WA. Thrives in both sub-tropical and temperate conditions. Long-lived summer active perennial grass that forms dense tussocks, up to 1.5 m. Invade pastures particularly where ground cover is low (< 70%) because of grazing regime and low soil fertility. Pastures dominated by it can be productive, although the management requirements are higher than that commonly employed (i.e. it needs to be kept short to meet feed requirement of dry stock). Has resulted in widespread changes in pastoral practice in affected areas, including through altered grazing management practices. "Coolatai grass presents a dilemma in that it is able to invade relatively undisturbed natural ecosystems, yet can be a resilient productive pasture species if managed correctly." http://www.dpi.nsw.gov.au/agriculture/pests-	Mod	Low-Mod	High likelihood that it will continue to expand its range in southern Australia. More easily managed perennial and annual pasture options are preferable to this grass.

		weeds/weeds/profiles/coolatai			
Hypericum perforatum	Mod	Widespread in humid and subhumid temperate regions, especially in Vic and NSW. Of minor importance in WA. Primarily invades poorly managed grazing land. Eaten by stock when other feed is scarce. Poisonous to stock not accustomed to it. Competes throughout the year with other species. Infestations are encouraged by heavy grazing. Pasture improvements following high defoliation by biological control agents (*Chrysolina* beetles) can be effective in some years, but not in all habitats, particularly in open woodland grazing systems. If grazing is carefully managed it will not cause serious enterprise-level production losses.	Low	Low-Mod	Expected to have the same impact as currently, unless its range increases in drier climates unsuitable for existing biocontrol agents.
Hypochaeris spp.	Neg	Common and widespread in NSW, Tas, ACT, Vic and south-eastern SA and south-western WA. Common in south-eastern QLD. Can become dominant where there is regular soil disturbance. Also dominates in situations of regular mowing and soil compaction. Rosettes can cover a relatively large area of soil and preclude recruitment by desirable species. Palatable to stock. Rotational grazing reduces infestations by encouraging grasses. Perennial pastures are more resilient to infestation. Mostly a nuisance weed that does not significantly affect production currently.	Neg	Neg-Low	Already widespread. Infestations could potentially increase in density in marginal grazing land.
Hyptis suaveolons	Neg	Unpalatable. A symptom of poor grazing management. Restricted in reach.	Neg	Neg-Low	Dense infestations are expected to remain restricted, and largely preventable through property management practices. Are invasions reversible?
Jatropha gossypiifolia	Low	Unpalatable. Forms extensive monocultures across major soil types/habitats across savannas, replacing palatable pastures. Difficult to manage, including through pasture management. Although widely distributed it is not yet thought to be causing serious enterprise-level impacts or, if it is, then serious impacts are limited to relatively few properties nationally.	Mod	Low-High	High based on expectations that it has the ability to form extensive monocultures in diverse environments (including uplands) across large parts of the savannas. It is not yet clear what grazing management or disturbance regimes are required for monocultures to occur. It remains costly to control. Naturally-occurring dieback is being reported in QLD.
Lantana camara	High	Toxic (to newly exposed livestock), competes with pasture, and interferes with mustering. A serious problem in wetter coastal zones from north QLD to northern NSW, has a wide ecological reach (open, woodlands, riparian), and is expensive and difficult to manage with existing options. Enterprise impacts are	High	Mod-High	Expected to continue to worsen (although land use is changing in at least some at-risk areas)

		substantial at a regional scale.			
Lantana montevidensis	Neg	Weed is widespread from Gladstone south through Monto, Blackbutt and through to Ipswich. It can take over paddocks, typically after prolonged drought, decreasing production. It is difficult to control. Greatest impacts are thought to occur in the Monto Region. Further information on impacts is required if this species is to be upgraded to Low or Moderate.	Low	Neg-Mod	Weed may spread to other regions. Less common in wetter regions. Need more information.
Lycium ferocissimum	Mod	Found throughout NSW, particularly in the western pastoral areas, and in Vic (worst infestations in the north). Established over large areas in northern marginal land in SA and occurs along most of the south west WA coast and hinterland. Creates impenetrable barriers to livestock, reducing access to pasture and water sources. Seldom grazed because of its sharp spines. Effective control requires the integration of a number of control methods and is thus costly – primarily chemical and physical means - with regular follow-ups. In contrast to gorse, it can produce flowers and seeds on old wood, a characteristic that enhances it capacity to spread.	Mod	Mod-High	High likelihood of infilling within its range in southern Australia, thus affecting more enterprises.
Marrubium vulgare	Low	Widespread, mostly in SA, NSW and Vic. Typically localised in extent in enterprises (e.g. around sheep camps), but can also invades pastures under favourable conditions (e.g. following drought). Seedlings however, do not establish in dense pastures. Not palatable to stock and thus infestations are encouraged by heavy grazing that reduce desirable pasture species. Relatively drought tolerant and will grow in very poor soil. Causes vegetable fault in wool. Biocontrol has shown promising signs but the agents have not yet reached high densities across the entire range of the weed to claim success.	Low	Neg-Low	Its importance/relevant for grazing enterprises may be significantly reduced if the biocontrol is successful across the weed range.
Mimosa diplotricha var. *diplotricha* (syn. *Mimosa invisa*)	Neg	Weed is not considered a major problem. It is under effective control by a psyllid biocontrol agent. New infestations can be managed through redistribution of the psyllid. It is unlikely to be considered a major problem.	Neg	Neg-Low	No reason for status to change into the future.
Mimosa pigra	Low	Forms extensive, permanent monocultures in wetlands in the Top End, NT replacing valuable pasture. It can do so in even relatively well managed properties (due in part to disturbance by feral animals). It is expensive to manage. It severely affects relatively few properties	Low	Low	High density infestations could increase where habitat is suitable (including the VRD and east Kimberley, WA, if containment is unsuccessful). Potential impact has been greatly reduced through biocontrol. Future

		across the Top End, NT, and only a proportion of the wetlands of those that are heavily invaded. Biocontrol has made it easier to manage.			impact is also dependent in part on the long term effects of dieback, which appears to be becoming more common, and the long-term future of feral animal management. Pastoral impacts will always be largely restricted to properties with high dependence on extensive wetlands.
Moraea flaccida and *M. miniata*	Mod	Both species occur in grazing land in southern Australia, especially in SA and WA, although *M. miniata* affect fewer enterprises across the range. Poisonous to stock, with cattle more susceptible than sheep. Avoidance of the weed by grazing animals contributes to its persistence. Where the problem is severe, farmers have had to abandon running stock on their properties, in particular in organic farming. Dormancy in corms makes control very difficult and means that methods must be applied at the right time and for several successive years (at least 4 yrs).	Mod	Mod-High	It may become prohibitive to manage heavy infestations, especially of *M. flaccida*, with current methods and more farmers may decide to opt out of livestock production altogether. *M. miniata* may expand its range over time and affect more enterprises.
Nassella neesiana	Mod	Scattered infestations in NSW and Vic. Palatable and considered to be a reasonable feed in winter but a poor feed when flowering and seeding. Causes vegetable fault in wool. Tolerates drought and heavy grazing. Vigorous and competitive against desirable pasture species. For best control a combination of methods is required (pasture sowing, herbicide and grazing management). Needs bare ground to establish so important to maintain good pasture cover.	Mod	Mod-High	Spreading fast through NSW and will become an increasingly poor quality competitive grass in grazing systems. However, better understanding is required regarding conditions required for it become dominant, and how extensive dominant infestations could become.
Nassella trichotoma	Mod	Distribution restricted to NSW and Vic. Found in open pastures and relatively resistant to drought. Eaten by cattle and sheep if nothing else is present, but animal are unable to digest it. Causes vegetable fault in wool. Even Moderate infestations can reduce carrying capacity by about 40%. Heavy grazing favours its persistence and spread. Seedlings cannot withstand strong pasture competition. Combination of cultivation and/or herbicide with pasture improvements (e.g. top dressing and sowing) and careful grazing management are necessary to effectively control it.	Mod	Mod-High	Still spreading and infilling. Least palatable grass weeds in the South East. Better understanding is required regarding conditions required for it become dominant, and how extensive dominant infestations could become.
Onopordum spp.	Mod	Found in subhumid and warm-temperate regions of southern Australia in pastures of reasonable fertility. Often establishes where pasture improvement has been attempted. Not eaten by stock. Incidence varies from year to year. Generally localised in extent within	Low	Low-Mod	Likely to continue to spread and affect more enterprises, but biocontrol agents should be able to stay on top of it and reduce populations and seed outputs.

		an enterprise (e.g. high soil fertility in animal camps favours establishment and growth). Competes well with pasture species in high rainfall areas. Dense patches hindered stock movement. Best ways to contain infestations is to combine cultivation, establishment of highly competitive pasture species and some herbicide spraying. Grazing of flowering plants by goats and to a lesser extent cattle can lead to a worthwhile reduction in seed production. Good biocontrol agents have been released and are still spreading.			
Opuntia and *Cylindropuntia* spp.	Low	Approximately 30 invasive species in this group in Australia which includes the spiny, vegetatively propagating *Cylindropuntia* and the mainly fruit-propagating *Opuntia*. *Cylindropuntia* spp. together with the other Opuntioid cacti present a threat to grazing industries through their ability to form dense infestations that can reduce access to feed and hinder mustering activities. Their spines can injure stock, damage fleece and hides and affect the safe handling of affected animals for shearing purposes. Stock does not generally feed on cacti. Their confined distributions are still relatively restricted.	Mod	Low-High	Low productivity land is at greatest risk. The expectation is that infestations, and impact, will become much worse. Depending on the location and density of an infestation, the cost of control may outweigh the economic value of the land. This can influence people's motivation to manage these plants, even if their impacts are known and understood. Great uncertainty regarding potential threat owing to lack of knowledge of existing infestations, and causes of invasions.
Cylindropuntia aurantica	Neg	Little information found on current extent of infestations. Qld, NSW, Vic, SA. Occurs throughout NSW (200 000 ha infested); southern QLD, Vic and SA.	Mod	Low-High	No specific information found. Great uncertainty regarding potential threat owing to lack of knowledge of existing infestations, and causes of invasions.
Cylindropuntia fulgida	Neg	No information found on current extent of infestations. Qld, NSW and WA Goldfields.	Mod	Low-High	No specific information found. Great uncertainty regarding potential threat owing to lack of knowledge of existing infestations, and causes of invasions.
Cylindropuntia imbricata	Neg	No information found on current extent of infestations. Most common in the Lower Darling, western NSW.	Mod	Low-High	No specific information found. Great uncertainty regarding potential threat owing to lack of knowledge of existing infestations, and causes of invasions.
Cylindropuntia rosea	Neg	Little information found on current extent of infestations. Principally in NSW (60,000 ha found around Lightening Ridge), southeast QLD, SA, the NT and Goldfields Region, WA.	Mod	Low-High	See extensive potential distribution in the WONS Opuntioid Weed management Guide. Great uncertainty regarding potential threat owing to lack of knowledge of existing infestations, and causes of invasions.
Cylindropuntia tunicata	Neg	No information found on current extent of infestations. NSW and WA Goldfields.	Mod	Low-High	See extensive potential distribution in the WONS Opuntioid Weed management Guide. Great uncertainty regarding potential threat owing to lack of knowledge of existing

					infestations, and causes of invasions.
Opuntia monocantha	Neg	No information found on current extent of infestations. SA.	Mod	Low-High	No specific information found. Great uncertainty regarding potential threat owing to lack of knowledge of existing infestations, and causes of invasions.
Opuntia robusta	Neg	Little information found on current extent of infestations. Occurs in Flinders Ranges (35,000 ha), in the mid-north and along the River Murray in SA, north central Vic, and southern NSW.	High	Low-High	See extensive potential distribution in the WONS Opuntioid Weed management Guide. Great uncertainty regarding potential threat owing to lack of knowledge of existing infestations, and causes of invasions.
Parkinsonia aculeata	Low	Widely distributed across the northern savannas. However, extensive infestations are rare, often short-lived (15-20 yrs, in part due to dieback), and mostly restricted to seasonally or periodically flooded habitats. Extensive infestations are rare. Existing infestations are relatively easily controlled (compared to other trees), although still costly. Relatively few properties nationally with severe infestations.	Low	Neg-Mod	Is expected to continue to invade more areas. However, there is no reason to believe that the dieback phenomenon will continue to limit extent, density and longevity of infestations.
Parthenium hysterophorus	Mod	Can dominate in some seasons in central QLD, but competitiveness (including size) greatly reduced through biocontrol. Poor competitor against perennial pastures. There are some doubts about whether infestations result in significant production losses, except perhaps in certain combination of seasons/years (reduced milk quality due to herds feeding on grass mixed with parthenium weed has been reported). It causes significant negative impacts on human and animal health. Extensive, dense infestations can be prevented by managing grazing and disturbance. Impacts are substantial on properties that are required to prevent spread (such as through hygiene practices, grain movement and wash-downs).	Mod	Low-High	The core infestations around central QLD are still extending into southern Qld and northern NSW. Impacts will depends in part on how well existing biocontrol agents will do in new range, and on whether parthenium will be able to compete with well managed pasture systems in those regions. Human health impacts expected to be much greater in high population areas (e.g. southeast QLD), with implications for the pastoral industry.
Phyla canescens	Mod	Well adapted to the floodplain environments of river systems in temperate and subtropical regions. It has become dense across large parts of grazing/floodplain country across a significant number of livestock enterprises in upper Murray Darling, some of which relying heavily on flood-plains for pasture. May require heavy, continuous grazing to become dominant (perhaps combined with drought conditions). It has no grazing value. Causes significant losses in carrying capacity and is difficult to control once established in areas where farmers cannot or will not cultivate. It	Mod	Low-Mod	Largely restricted to periodically flooded habitats in the right climate. Is likely to continue to impact more areas in more enterprises. Once established, it typically does not retreat easily.

		requires an integrated approach of suppression, pasture improvement and pasture maintenance to manage.			
Physalis viscosa	Low	Restricted distribution to warm-temperate regions of Vic and southern NSW. Has a deep root system similar to silver leaf nightshade, which makes control difficult when regrowth occur. Good competitor with summer crops, but becoming an increasing issues in grazing pastures in SE Australia. Cultivation is ineffective and chemical control difficult when treating regrowth from deep roots.	Mod	Mod-High	Expected to increase in importance, although a lot of uncertainty since it has remained relatively stable over the last 20 years.
Prosopis spp.	Low	Becomes dense in apparently well managed properties. Serious enterprise level losses through reduced carrying capacity, infrastructure maintenance, mustering, but currently only on several properties nationally. Expensive to manage.	High	Mod-High	Currently dense infestations have restricted distributions but mesquite is able to form extensive dense infestations across large areas apparently irrespective of grazing management practices. Existing control tools available but expensive. Extensive isolated to sparse infestations across large areas and many properties (mainly QLD) suggest that future impacts will be moderate to high.
Raphanus raphanistrum	Low	Widespread in temperate regions. An important weed of cereal crops, which is also found in degraded pastures and pastures that were cropped in the past. A serious competitor that can reduce pasture yield. Unpalatable and can sometimes result in stock poisoning at high density. Maintaining a vigorous pasture with regular topdressing and light to Moderate grazing prevent infestation. It can be controlled by herbicides in a cropping phase (e.g. oats), but the emergence of herbicide resistance in this weed has become a major issue.	Low	Neg-Low	Unlikely to become a major problem since it is primarily a weed of cultivation. Can be managed by grazing and establishing permanent pasture.
Reseda lutea	Low	Scattered distribution in temperate Australia. Mainly a weed of roadsides and waste spaces, which sometimes encroaches onto regenerating pastures, competing with desirable plants. Deep-rooted perennial that is not controlled by cultivation, grazing and mowing. Can be controlled with herbicide when young, but older plants are resistant.	Low	Low	Has potential of further spread and infilling, but unlikely to cause serious enterprise-level production losses.
Romulea rosea	Mod	Widely distributed throughout temperate and Mediterranean areas. Affects both composition and agronomic performance of pastures that are infertile and with compacted soils. Palatable but has no nutritional benefit, but causes phytobezoar (a fibrous	Low	Low-Mod	Impact on enterprises unlikely to change. Has probably reached all suitable habitats and further expansion in distribution unlikely under current climate.

		ball that blocks the digestive system). Grazing animals can play a major role in dispersing seed. Produces both seeds and corms, which make control difficult. A regular pasture renovation program (cultivation and resowing pasture species) helps control this weed.			
Rosa rubiginosa	Low	Distributed in humid and subhumid temperate regions, mainly in eastern Australia. Young seedlings are not very competitive and few survive grazing. Not a problem in well maintained, sown pastures and therefore not consider to cause major enterprise-level production losses. Shrubs' prickly nature deters livestock from grazing close to plants. Dense patches can restrict movement to watering points.	Low	Neg-Low	Impact on enterprises unlikely to change. Has probably reached all suitable habitats and further expansion in distribution unlikely under current climate.
Rubus fruticosus agg. (primarily *R. anglocandicans*)	Mod	Widespread in southern Australia. Can restrict livestock movement and access to water courses, and reduce available grazing land. Typically localised in extent within an enterprise. Unpalatable to cattle and sheep, but eaten by goats. Rarely invades dense, well-managed pastures. Chemical treatment is the most practical method of control. Biocontrol has had some impact in reducing seed production but limited impact in reducing stand size and density, except in cool and high rainfall areas (e.g. Victorian high country).	Mod	Low-Mod	Impact on enterprises unlikely to change. Has probably reached all suitable habitats and further expansion in distribution unlikely under current climate.
Rumex spp.	Neg	Widespread in cool to mildly warm temperate regions. Unpalatable to livestock, but young plants and flower stems are eaten. *R. crispus, R. pulcher* and *R. obtusifolius* can be strongly competitive in pasture. Has been regarded as the major weed of pasture in south west WA. Maintaining vigorous pasture and avoiding over-grazing help control infestations over time. Biocontrol program has been very effective across most of its range in WA.	Neg	Neg-Low	Impact on enterprises unlikely to change given successful biocontrol. Has probably reached all suitable habitats and further expansion in distribution unlikely under current climate.
Senecio jacobaea	Low	Present in humid temperate regions, primarily in Vic and Tas. Commonly found in poorly managed, degraded pastures, although pasture improvement alone does not control established stands. Poisonous to livestock, but selectively avoided. Biological control has been successful in most areas and has resulted in a decline in its economic impact on grazing industries in Tas. Still a sporadic problem in Vic..	Neg	Neg-Low	Impact on enterprises unlikely to change. Has probably reached all suitable habitats and further expansion in distribution unlikely under current climate.
Senecio madagascariensis	Mod	Infests primarily coastal pastures in south-eastern Australia, but is also present in the NSW tablelands and in south-east QLD. If eaten it can cause liver damage in	Mod	Mod-High	Has potential to spread over a much broader area in southern Australia than it currently occupies.

		cattle and possible death. It can be most successfully controlled with sheep and goat grazing and pasture improvement, including reduced grazing pressure or grazing rotation strategies. Farmers spend considerable time and money managing it and thus it significantly impacts on farm profitability.			
Senna obtusifolia	Neg	Extensive dense infestations common across northern Australia, but may primarily be restricted to highly disturbed habitats such as watering points and already heavily disturbed riparian zones. Its' main impact is perceived as pasture competition, but its reach is probably not great in most well-managed pastoral properties.	Low	Neg-Mod	There is considerable uncertainty regarding the situations under which it becomes dense. Affected areas on Cape York are not well studied. QPWS consider that it is spreading into National Parks.
Solanum elaeagnifolium	Mod	Widespread throughout temperate Australia, except Tas. Infrequent in WA. Mainly a problem in cropping areas, but also reported to affect summer growing and annual pastures by reducing carrying capacity. It can be grazed by stock if other palatable species are absent. Cattle are more susceptible than sheep to toxins contained in plants (no death recorded in Australia though). Its extensive and interconnected root system makes control difficult and costly.	Mod	Mod-High	Likely to continue to spread and therefore has potential to significantly affect many more grazing enterprises.
Sporobulus spp.	Mod	Five species currently impacting the pastoral industry. Together they already cause severe impact along the eastern seaboard, at least locally. Some species still viewed as emerging problems. Little recent information on scale of enterprise-level impacts, regional extent of impact, and to what extent problems are a function are a function of high disturbance.	Mod	Low-Mod	Little data or direct observation to support projections. Better understanding is required regarding conditions required for it become dominant, and how extensive dominant infestations could become.
Sporobolus africanus	Low	Dairy industry in Vic views it as a major problem, especially the northern irrigation area where it is invading high input irrigated pasture and severely reducing milk production on heavily infested properties. We couldn't confirm how serious it is in well managed enterprises across a broad geographic area, nor how easily managed it is. The implication is that it requires heavy, continuous grazing to become dominant.	Mod	Low-Mod	Little data or direct observation to support projections. Better understanding is required regarding conditions required for it become dominant, and how extensive dominant infestations could become.
Sporobolus fertilis (syn *S. indicus* var. *major)*	Mod	It is considered to cause important pastoral losses in northern NSW, although there is considerable variation in what individual people think of it (D. Officer, pers. comm. 2012). It can cause serious problems in pastures in the wetter areas on the north coast of New South Wales. It is of low palatability, completely	Mod	Low-Mod	Little data or direct observation to support projections. Better understanding is required regarding conditions required for it become dominant, and how extensive dominant infestations could become.

		replacing desirable pasture species, with farmers reporting 10-80% losses in carrying capacity. Cattle also take significantly longer to reach equivalent weights compared to those grazing in un-infested pastures. We couldn't confirm how serious it is in well managed enterprises across a broad geographic area, nor how easily managed it is. The implication is that it requires heavy, continuous grazing to become dominant.			
Sporobolus jacquemontii	Low	Recognised as a serious problem in the Burdekin area of northern QLD, where it is already causing significant reductions in carrying capacity, and changed management practice, although there has been almost no research work done on this species to date. It can cause serious problems on relatively well-managed properties, although it does best in overgrazed areas. We couldn't confirm how serious it is in well managed enterprises across a broad geographic area, nor how easily managed it is. The implication is that it requires heavy, continuous grazing to become dominant.	Mod	Low-Mod	Little data or direct observation to support projections. Better understanding is required regarding conditions required for it become dominant, and how extensive dominant infestations could become.
Sporobolus natalensis	Mod	Unpalatable, can invade relatively intact pastures, and very difficult to manage once established. Greatest problems currently in coastal districts of QLD and northern new South Wales, where it has resulted in substantial reductions in stocking capacity, in cattle taking considerably longer to reach desired weights, high costs in milk production on dairy farms, high management costs, and reduced land values of highly infested lands. Anecdotal evidence suggests it can reduce the productivity of beef and dairy enterprises by half, while attempting control can incur major costs. Serious issue in western part of Atherton Tablelands, resulting in changed management practice. We couldn't confirm how serious it is in well managed enterprises across a broad geographic area, nor how easily managed it is. The implication is that it requires heavy, continuous grazing to become dominant.	Mod	Low-Mod	Little data or direct observation to support projections. Better understanding is required regarding conditions required for it become dominant, and how extensive dominant infestations could become
Sporobolus pyramidalis	Mod	Unpalatable, can invade relatively intact pastures, and is very difficult to manage once established. Greatest problems currently in coastal QLD, where it has resulted in substantial reductions in stocking capacity, cattle taking considerably longer to reach desired weights, higher costs in milk production on dairy farms,	Mod	Low-Mod	Little data or direct observation to support projections. Better understanding is required regarding conditions required for it become dominant, and how extensive dominant infestations could become

		and reduced land values of highly infested properties. Anecdotal evidence suggests it can reduce the productivity of beef and dairy enterprises by half while attempting control can incur major costs. Could not confirm how serious it is in well managed enterprises across a broad geographic area, nor how easily managed it is now.			
Tamarix aphylla	Neg	Isolated plants found across the inland, but they rarely naturalise. A few extensive infestations (e.g. Finke River, NT and Gascoyne River, WA) demonstrate its potential to form monocultures in certain arid and semi-arid riparian systems where it could hamper stock access to water. It also has the potential to increase surface soil salinity. Not thorny or toxic. Currently restricted to very small parts of a few properties, with little or no impact on enterprise (although substantial government funds are being spent on containment and eradication). Very costly to control.	Neg	Neg-Low	Primarily of environmental concern, restricted to particular river systems. Extensive dense riparian infestations may result in altered hydrology, flooding patterns, etc. that may have serious flow on impacts for managing pastoral properties. Not likely to be a problem except in the driest areas of central southern Australia.
Themeda quadrivalvis	Neg	In Lakefield National Park (northern QLD) it is replacing and dominating savannah grasslands (including native perennial grasses) under relatively natural disturbance regimes where soil types are favourable. However, gaining dominance most commonly requires bare ground resulting from heavy cattle grazing or poor fire management regimes. Serious enterprise-level impacts not yet identified. Mostly viewed as an emerging problem.	Low	Neg-Mod	Expected to continue to invade when opportunities arise. It is a high biomass grass which can subsequently outcompete perennials if not managed properly, despite basically being annual. Few management options currently available beyond grazing management. Future impact will depend in part on its competitiveness on well managed enterprises.
Tribulus terrestris	Neg	Widespread but mainly a nuisance weed that does not significantly affect production and management of grazing enterprises. Especially found in overgrazed pastures where there is little competition. Sharp spines on fruits hamper stock handling. Poisoning can occur in young sheep grazing on it.	Neg	Neg-Low	Impact on enterprises unlikely to change. Has probably reached all suitable habitats and further expansion in distribution unlikely under current climate.
Ulex europaeus	Mod	Mainly a weed of unimproved grazing land in high rainfall areas of temperate regions (primarily Tas and Vic). Unpalatable to cattle. Mature growth eaten by goats, but only new growth is palatable to sheep. Blocks access and prevents movements of stock. Control is costly because a combination of different methods is required and follow-up is necessary. Biocontrol agents released so far have not proved to be effective in managing populations.	Mod	Low-High	Has probably reached its potential range. Infilling could lead to problems for currently un-infested enterprises.
Vachellia nilotica ssp.	High	Heavy infestations result in pasture loss, and also affect	High	High	The problem is expected to continue to

indica (syn *Acacia nilotica* ssp. *indica*)		mustering and can result in erosion. Control is expensive once widely established. There are already enterprise-level impacts across large parts of the Mitchell grasslands in QLD, including on well-managed properties.			worsen in the absence of new control options. This includes black soil plains and other habitats across the northern savannas.
Vulpia spp.	Low	Exotic annual grass that competes with more desirable pastures in temperate areas and produces lower quality feed. It has however, some grazing value at times of the year and therefore cannot be considered as causing serious enterprise-level production losses. Management strategies involving tactical grazing and fertiliser use can significantly reduce the vulpia content of pastures, which can be maintained with good grazing management.	Low	Low-Mod	Already very widespread. Infestations could potentially increase in density in marginal grazing land.
Xanthium occidentale (syn *X. strumarium*)	Low	Used to be a major problem in south-east QLD, but since the introduction of a rust fungus populations have drastically declined and it is now a minor weed. It is still found along river systems in NSW, NT and northern WA, but doesn't specifically affect livestock enterprises. Seedlings poisonous to livestock. Burrs contaminate wool and can reduce value.	Low	Neg-Low	Has potential to become more of a problem for grazing properties along the Murrumbidgee river, where climate is not conducive to severe epidemics by the rust biocontrol agent, which has been highly effective in controlling the weed in south-east QLD.
Xanthium spinosum	Low	Widespread, but generally localised within enterprises to high fertility disturbed areas i.e. associated with sheep camps and wet areas (watercourses, dam banks, flood plain). Seedlings are poisonous to livestock but it is not a major problem in Australia. It is one of the causes of vegetable faults in Australian wool.	Low	Low-Mod	Already widespread. Infestations could potentially increase in density in marginal grazing land.
Ziziphus mauritiana	Low	Beginning to form dense infestations on significant parts of properties in the Charters Towers to Townsville area of QLD with loss of pasture, difficulties in riparian access and mustering. Dense along riparian strips but also uplands particularly in wetter areas. Has particularly slow rate of increase, but once established doesn't go away and is very difficult to manage. Can become dense even under relatively good management.	Mod	Mod-High	Infestations continue to increase in size and density, albeit very slowly due to slow population growth rates. It is has the potential to become dominant over large well-managed areas, at least initially in Charter Towers/Townsville region of QLD where it is already widely established. There are no cost-effective management options on the horizon beyond managing large trees which contribute most seed. However, management is aided by slow growth rates.

7.7 Appendix 7

Primary goal(s) of biocontrol program, prospects for biocontrol with new agents and proposed key investment area(s) (i.e. actions that could change rankings of biocontrol feasibility and/or likelihood of success) for the weeds assessed through the prioritisation framework.

Weed taxa	Primary goal(s) for biocontrol program	Biocontrol prospects	Biocontrol prospects explanation	Key investment area(s)
Andropogon gayanus	Reduce fuel load to avoid high to catastrophic fire that affect properties across savannas. Reduce loss of livestock carrying capacity as a result of pastures being replaced by high biomass gamba that remains "rank" for long periods. Slow spread (including in QLD).	Low	Several barriers to successful biocontrol, but good reasons to suggest that these could be addressed and overcome within a reasonable time span.	1. Obtain support as target for biocontrol, including conducting necessary stakeholder consultation. 2. Preliminary surveys to determine extent of native range (including of relevant "sub species") and their natural enemies.
Arctotheca calendula	Improve livestock carrying livestock capacity by reducing population density and competitive ability. Reduce prevalence of the most important pasture pest of southern Australia, red legged earth mite, which uses the weed for shelter.	Low-Mod	The main initial barrier to biocontrol is the possible conflict between those who value the plant in WA and others who consider it weedy in the eastern states.	1. Perform a genetic study to determine if there are differences between the putative eastern and western forms of the weed to decide if biocontrol is a viable option considering potential conflict between eastern and western graziers.
Asphodelus fistulosus	Improve livestock carrying livestock capacity by reducing population density and competitive ability.	Mod	The main barrier to the initiation of a biocontrol program is the current lack of data on impact of the weed to support a nomination as a biocontrol target. There is good prospect of finding a host-specific rust strain that would cause sufficient damage on the weed across part of its range.	1. Determine if there are sufficient data to support nomination as a biocontrol target; if so nominate. 2. Test rust strains on Australian accessions of the weed to determine if there are any genotype matching issues. 3. Conduct preliminary tests on a few key native species in the Xanthorrhoeaceae family before embarking on a comprehensive host-specificity testing program.
Bryophyllum delagoense	Improve farm management by not having to consider risk of poisoning of naïve livestock when moving them within and between properties.	Low-Mod	Potential agents are limited to 2 stem-boring weevils. The Biocontrol Act will need to be used to gain approval for release because of host range issues.	1. Follow the two tested beetle species through the Biocontrol Act. This would require quantification of actual and potential impact of the target (and non-targets). 2. Critically assess past exploration/testing work to determine whether other options are available.
Calotropis procera	Make it less competitive so that it doesn't become dominant, or persist, even under moderately high levels of disturbance	Mod	Likely to be find host-specific agents. Goals for biocontrol are relatively achievable provided	1. Better understand potential impact of the weed, including relationship to grazing management regimes, and longevity of existing

	(such as around water points).		the right types of agents can be found.	infestations. 2. Assess existing potential agents against likelihood of impact, prior to host-range testing. 3. Conduct native-range surveys, once it has been established.
Carduus nutans	Improve livestock production on farm by increasing access to more pasture by reducing weed patch size, population density and biomass. Reduce the need of and/or frequency of other weed management tactics by lowering recruitment of the weed. Reduce the spread of the weed by reducing seed availability (propagule pressure).	Low	Biocontrol program established many years ago and having a major impact. No new agents expected to be found in the native range that could enhance existing biocontrol.	No actions identified.
Carduus tenuiflorus and *C. pycnocephalus*	Improve livestock production on farm by increasing access to more pasture by reducing weed patch size, population density and biomass. Reduce the need of and/or frequency of other weed management tactics by lowering recruitment of the weed. Reduce the spread of the weed by reducing seed availability (propagule pressure).	Mod	While crown-feeding rosette agents have been successful for other thistle species, there are no options to enhance biocontrol of this species because of lack of additional specific agents.	1. Perform gap analysis of previous surveys data to better assess chances of finding a host-specific rosette-feeding insect agent.
Carthamus lanatus	Improve livestock production on farm by increasing access to more pasture by reducing weed patch size, population density and biomass. Reduce the need of and/or frequency of other weed management tactics by lowering recruitment of the weed. Reduce the spread of the weed by reducing seed availability (propagule pressure).	Low-Mod	Only one possible agent available for biocontrol considering the likely conflict that would occur should agents that affect safflower are proposed for release.	1. Investigate impact of the rosette crown-feeding fly in a plant competition experiment to better assess its potential for biocontrol. 2. If point 1 is promising, then nominate the weed as a biocontrol target. 3. Undertake comprehensive host-specificity testing with the fly.
Cenchrus pedicellatus and *C. polystachios*	Future grazing management in northern savannas not dictated by weed (through reduced competitiveness)	Low	Expected to be a challenging target with high host-specificity requirements.	1. Nominate as target. 2. Confirm taxonomy/origin. 3. Conduct preliminary native range surveying, perhaps piggy-backed on to other work.
Chromolaena odorata	Slowing spread to allow time for "transition to management", reducing its ability to become dominant in pasture systems across northern Australia.	High	A range of well-studied agents available from overseas, including species that have been effective on the same genotype	1. Determine and progress with the most promising agents from overseas (work is already underway).

			and under similar conditions.	
Cirsium arvense	Improve livestock production on farm by increasing access to more pasture by reducing weed patch size, population density and biomass. Reduce the need of and/or frequency of other weed management tactics by lowering recruitment of the weed. Reduce the spread of the weed by reducing seed availability (propagule pressure).	Mod	Good prospect to find additional host-specific biocontrol agents considering that Australia does not have native *Cirsium* spp. However, precedents in other countries indicate that very high levels of damage would be required to control the weed.	1. Wait for results from New Zealand on impact of new agents released or to be released. 2. If point 1 is promising, conduct preliminary host-specificity tests to confirm that they do not attack Australian native species in the tribe Cardueae before any further assessment.
Cirsium vulgare	Improve livestock production on farm by increasing access to more pasture by reducing weed patch size, population density and biomass. Reduce the need of and/or frequency of other weed management tactics by lowering recruitment of the weed. Reduce the spread of the weed by reducing seed availability (propagule pressure).	Mod-High	Good prospect to find additional host-specific biocontrol agents considering that Australia does not have native *Cirsium* spp. Finding a damaging crown-root weevil would complement existing agents and increase likelihood of achieving successful biocontrol.	1. Investigate the genetics of the weed to identify most appropriate areas of native range to survey to find a crown-root weevil that attack the form of *C. vulgare* presents in Australia.
Cryptostegia grandiflora	Reduce pasture loss by making existing infestations in high-value habitats smaller and less dense, especially in areas where the existing rust pathogen doesn't perform so well (northern and drier areas). Prevent future impacts by reducing its ability to become dense in new areas.	Low	Unlikely to find further host-specific agents.	1. Critically assess past exploration/testing work to determine whether other options are available.
Cytisus scoparius	Prevent it from forming extensive, dense infestations that will cause lost production and seriously impact property management. Make it affordable to manage using existing chemical and mechanical control tools. Slow the spread to other areas by reducing seed outputs.	Low	Prospect to introduce additional agents is limited because of lack of specificity. Integration of current biocontrol agents with other control methods that specifically target recruitment from the large and long-lasting seedbank following death of adult plants may be a more appropriate approach.	No actions identified.
Echium plantagineum	Improve livestock carrying capacity by reducing population density and competitive ability.	Low	Biocontrol program established many years ago and having a major impact. No new agents expected to be found in the native range that could enhance	No actions identified.

			existing biocontrol.	
Emex australis	Improve livestock carrying capacity by reducing population density and competitive ability.	Low	Biocontrol program established years ago without any agent becoming established. Potential agents remain to be investigated, but will need to take into account weeds annual lifecycle and dry hot conditions or region infested.	1. Recollect the weevil *P. neofallax* in Tunisia and develop appropriate rearing techniques so that preliminary testing on native *Rumex* spp. can be undertaken to assess its potential for biocontrol. 2. Assess *Cercospora* spp. from Africa.
Eragrostis curvula	Grazing management is not dictated by weed (through reduced competitiveness), thus improving farm management operations.	Unfeasible	An unfeasible biocontrol target as species can be both problematic and useful as a pasture, depending on setting and cultivar.	No actions identified.
Euphorbia terracina	Improve livestock carrying capacity by reducing population density and competitive ability.	Mod	Good prospect to find a rust strain that would not pose a threat to Australian native Euphorbia spp. High level of defoliation would be required since the plant is a long-lived perennial with a basal crown.	1. Determine if there are sufficient data to support nomination as a biocontrol target; if so nominate. 2. Perform an initial survey, especially to find the rust pathogen so that testing on Australian accessions of the weed can be performed to determine if there are any genotype matching issues. 3. Perform preliminary testing on key native *Euphorbia* spp. to obtain an indication of host-specificity before embarking on a comprehensive host-specificity testing program.
Harrisia martinii	Prevent it from emerging as a serious problem (to livestock carrying capacity and farm management) in southern QLD.	Low	Comprehensively surveyed. No further host-specific agents expected to be found.	1. Critically assess past exploration/testing work to determine whether other options are available.
Hordeum spp.	Reduce the need and/or frequency of other weed management tactics by reducing seed production.	Unfeasible	Unsuitable target for classical biocontrol. Desirable fodder at some times of the year and closely-related to barley, a major crop.	No actions identified.
Hyparrhenia hirta	Prevent it from emerging as a serious problem (to livestock carrying capacity and farm management) in southern QLD.	Low	Poorly studied species with native congeners. It is expected, in the absence of further information, to be a difficult target.	1. Determine native-range and conduct preliminary surveys of natural enemies.
Hypericum perforatum	Grazing management is not dictated by weed (through reduced competitiveness), thus improving farm management operations.	Low	Low prospects to find additional agents with good potential to enhance biocontrol of this weed across its range.	1. Consider performing an additional survey in the native range specifically targeting potential pathogen agents.

Jatropha gossypiifolia	Avoid future impacts (to livestock carrying capacity) across the savannas by preventing formation of extensive monocultures, or allowing that to be achieved by making other management options cost-effective and achievable	Low-Mod	Rust offers best opportunity, although it may not be sufficiently host-specific. Further potential agents unlikely, and it remains a moderately challenging biocontrol target.	1. Complete host-specificity testing of rust, and release if safe. 2. Targeted exploration of congeners outside of the weed native range in South America.
Lantana camara	Improve production by reducing cover of existing infestations and making lantana less likely to become dense. Priority areas are along and east of the Great Dividing Range (e.g. around Townsville, south-east QLD and northern NSW), including in open woodlands, riparian zones and open grasslands.	Mod	Further host-specific agents are likely to be found, but lantana in Australia will likely remain a challenging biocontrol target.	1. Conduct comprehensive gap analysis of historical native-range surveying in the light of recent genetic studies, and evaluate the potential for locating potentially damaging agents. 2. Consider further survey work, based on the gap analysis, specifically focussed on potential agents that are most likely to result in biocontrol goals being met.
Lantana montevidensis	Reduce potential impacts by making it less likely to become dense.	Mod	A poorly understood species. No apparent barriers to finding host-specific agents, but experiences from *L. camara* suggest that it could be a challenging target.	1. Need to know a lot more about the target before commencing a serious biocontrol effort.
Lycium ferocissimum	Prevent it from forming extensive, dense infestations that will cause lost production and seriously impact property management. Make it affordable to manage using existing chemical and mechanical control tools. Slow the spread to other areas by reducing seed outputs.	Mod	Hardy target that would require extensive defoliation over several years to reduce density and biomass of infestations. Good prospect of finding host-specific agents (e.g. rust) that will be damaging.	1. Nominate as a biocontrol target. 2. Perform an initial survey, especially to find the rust pathogen so that testing on Australian accessions of the weed can be performed to determine if there are any genotype matching issues. 3. Perform preliminary tests on the native *Lycium australe* to obtain a key indication of host-specificity before embarking on a comprehensive host-specificity testing program.
Marrubium vulgare	Improve livestock carrying capacity by reducing population density and competitive ability.	Mod-High	Good prospect that already identified potential insect agents will be host-specific. Difficult to predict though that they will be damaging in areas where existing agents are not performing well.	1. Recollect and attempt again to establish colonies of the three potential agents identified during surveys so that host-specificity tests can be performed. 2. If insect agents proved too difficult to rear, consider undertaking additional surveys specifically for pathogens.
Mimosa pigra	Improve livestock carrying capacity in invaded wetlands by reducing cover, and reduce control costs.	Low	It is a relatively challenging biocontrol target. Furthermore, additional host-specific agents are unlikely to be found.	No actions identified.
Moraea flaccida and *M. miniata*	Improve livestock carrying capacity by reducing population density and	Mod-High	Prospect of biocontrol with the rust fungus is promising.	1. Finalise identification of Australian genotypes and use these to source virulent rust strains for

	competitive ability.		However, more than one strains of the rust are likely to be required to attack the range of genotypes found in Australia.	subsequent host-specificity testing.
Nassella neesiana	Grazing management is not dictated by weed (through reduced competitiveness), thus improving farm management operations. Slow the spread to other areas by reducing seed outputs.	Low-Mod	There is some prospect that host-specific and damaging strains of the two candidate rust fungi, which have not been thoroughly investigated, could be found.	1. Consider comments received on application for release of *Uromyces pencanus* in Australia and undertake additional tests if necessary to support risk analysis (could wait to see how the rust establishes and spreads in New Zealand, where it has been approved for release, before investing in additional tests). 2. Re-assess previous research and decide if additional efforts are warranted to further explore *Puccinia nassellae* and *Puccinia graminella* for Chilean needle grass biocontrol in Australia.
Nassella trichotoma	Grazing management is not dictated by weed (through reduced competitiveness), thus improving farm management operations. Slow the spread to other areas by reducing seed outputs.	Low	Considering past efforts, there is a low prospect that host-specific and highly damaging strains of the candidate pathogen agents identified could be found.	No actions identified considering the major efforts of the last 10 years to find a classical biocontrol solution for this target.
Onopordum spp.	Improve livestock production on farm by increasing access to more pasture by reducing weed patch size, population density and biomass. Reduce the need of and/or frequency of other weed management tactics by lowering recruitment of the weed. Reduce the spread of the weed by reducing seed availability (propagule pressure).	Low	Biocontrol program established many years ago and believed to be having an impact but never quantified. No new agents expected to be found in the native range that could enhance existing biocontrol.	No actions identified.
Opuntia & *Cylindropuntia* spp.	Prevent it from forming extensive, dense infestations that will cause lost production and seriously impact property management. Make it affordable to manage using existing chemical and mechanical control tools. Reduce and maintain it at the same level as prickly pear.	Mod-High	The main barrier to successful biocontrol is the range of species and geographic regions to be targeted. Nonetheless, there are considerable synergies possible from addressing them simultaneously.	1. Clarify the taxonomy of naturalised species in Australia, and prioritise them for biocontrol. 2. Synthesis and gap-analysis of past work, including identifying biocontrol taxa already present in Australia. 3. Consider assessing the identified races of *Cactoblastis* and *Dactylopius* (cochineal insects) against the Australian invasive taxa (in a matrix design) to identify those that will have greatest impact on the highest priority Opuntioid species.
Parkinsonia aculeata	Mustering not hampered by weed and reduce cost of control. The highest priority	Low	A reasonably difficult target with few prospects of finding further	1. Additional surveying in the few remaining areas identified by native-range survey analysis

	is central QLD to the Gulf of Carpentaria and Barkly Tablelands.		host-specific, damaging agents (following release of the 2 geometrid agents).	that are most likely to yield additional agents. This includes resolving the taxonomy in South American native range (esp Argentina) to guide searches.
Parthenium hysterophorus	Grazing management in affected areas not dictated by weed (through reduced competitiveness), especially in at risk areas such as southern QLD and northern NSW. Reduce potential human-health effects (caused by pollen) that are expected to result from increased densities in high population areas such as southeast QLD.	Low	Further potential agents are considered unlikely. Furthermore, it remains a relatively difficult target.	No actions identified.
Phyla canescens	Increased livestock carrying livestock capacity in wetlands through decrease in cover. Grazing management is not dictated by the weed (through reduced competitiveness), thus improving farm management operations, including reliance on cultivation as a management tool.	Low	Hardy plant that spreads both clonally and by seed, with few prospects of finding agents capable of causing the required damage to survival and reproduction.	1. Locate rust on *P. reptans* and determine its relative preference for *P. canescens*. This is likely to require dedicated resources and development of contacts in Bolivia. Rusts have good track records as biocontrol agents.
Physalis viscosa	Improve livestock carrying capacity by reducing population density and competitive ability.	Low-Mod	A challenging biocontrol target because of its closeness to Cape gooseberry and native *Physalis* spp. Prospect may increase once knowledge of natural enemies is obtained.	1. Determine if there are sufficient data to support nomination as a biocontrol target; if so nominate. 2. Perform genetic study to identify more precisely region of origin of Australian populations. 3. Perform an initial survey of insect and fungi natural enemies there.
Prosopis spp.	Avoid future impacts (to livestock carrying capacity and property management) by preventing formation of extensive monocultures, or allowing that to be achieved by making other management options cost-effective and achievable.	Mod-High	A hardy host, but reasons to believe that sufficiently host-specific and damaging agents could be found and studied relatively easily.	1. Confirm high feasibility through a gap analysis of previous work and more comprehensive survey. 2. Host testing of potential agents following careful prioritisation based on potential impact, including evaluation of South African work.
Raphanus raphanistrum	Improve livestock carrying capacity by reducing population density and competitive ability.	Low	Low prospect of finding host-specific agents that are highly damaging. Very closely related to edible radish.	No actions identified.
Reseda lutea	Improve livestock carrying capacity by reducing population density and competitive ability.	Low	Low prospect of finding host-specific agents that are damaging to the roots, stems	No actions identified, beside establishing if it is a weed that is of real concern to grazing industries. It is mainly a weed of cropping and

			and/or foliage of the weed.	may only be relevant to grazing within the context of grazing-crop rotation.
Romulea rosea	Improve livestock carrying capacity by reducing population density and competitive ability. Reduce the need and/or frequency of other weed management tactics by reducing seed production.	Low-Mod	Although has not been surveyed before, there is some prospect of finding host-specific agent(s) that will be impactful since the weed is sensitive to defoliation (because it has few leaves).	1. Determine if there are sufficient data to support nomination as a biocontrol target; if so nominate. 2. Perform an initial survey, especially to find the rust pathogen so that testing on Australian accessions of the weed can be performed to determine if there are any genotype matching issues. 3. Perform preliminary tests on ornamental *Gladiolus* spp. grown in Australia to obtain a key indication of host-specificity before embarking on a comprehensive host-specificity testing program.
Rosa rubiginosa	Prevent it from forming extensive, dense infestations that will cause lost production and seriously impact property management. Make it affordable to manage using existing chemical and mechanical control tools.	Low	Low prospect of finding sufficiently host-specific agents because of the weed's close-relationship with ornamental roses. Would likely require a suite of damaging agents to reduce density of infestations.	1. Determine if there are sufficient data to support nomination as a biocontrol target; if so nominate. 2. Conduct survey in native range for pathogens, as they are the most likely options to achieve the level of host-specificity required.
Rubus fruticosus agg. (primarily *R. anglocandicans*)	Prevent it from forming extensive, dense infestations that will cause lost production and seriously impact property management. Make it affordable to manage using existing chemical and mechanical control tools. Slow the spread to other areas by reducing seed outputs.	Low	Low prospect of finding new agents that are sufficiently host-specific and damaging to have a significant impact on populations.	1. Assess research undertaken so far on the purple blotch fungus, *Septocyta ruborum*, and the likelihood of finding pathotypes that will solely attack invasive *Rubus* spp. 2. Perform a survey for new natural enemies in the UK where the most important species, *R. anglocandicans*, putatively originates from.
Senecio jacobaea	Improve livestock carrying capacity by reducing population density and competitive ability.	Low	Biocontrol program established many years ago and having a major impact. No new agents expected to be found in the native range that could enhance existing biocontrol.	No actions identified.
Senecio madagascariensis	Improve livestock carrying capacity by lowering pasture toxicity and increasing pasture production by reducing population density and competitive ability. Grazing management is not dictated by weed (through reduced competition), thus	Low	A challenging biocontrol target because of its closeness to native *Senecio* spp. and apparent ability to cope with high levels of damage from natural enemies.	1. Continue surveys for natural enemies in South African native range to identify promising candidates. 2. If candidates are found, perform preliminary host-specificity testing on key native *Senecio* spp. to determine their potential for biocontrol in

	improving farm management operations. Slow the spread to other areas by reducing seed outputs.			Australia.
Senna obtusifolia	Prevent future impacts on livestock carrying capacity by prevent it from becoming dominant across extensive pastures.	Low	Further potential agents is unconsidered unlikely, in part owing to high host-specificity requirements.	1. Gap analysis of previous survey efforts, with possibility of a few more years of targeted survey work in Central America. Possibly target pathogens with higher likelihood of specificity.
Solanum elaeagnifolium	Improve livestock carrying livestock capacity by reducing population density and competitive ability. Slow the spread to other areas by reducing seed outputs.	Low-Mod	A challenging biocontrol target because of its closeness to economically important and native *Solanum* spp. There is however, evidence from South Africa that it can be successfully control by defoliating agents.	1. Carry out additional surveys for natural enemies if the precise origin of Australian populations in the native range, which is currently being identified in an international genetic study, corresponds to regions that have never before been explored.
Sporobulus spp.	Grazing management not dictated by weed (through reduced competitiveness)	Low	Further options for surveying, but likelihood of finding sufficiently host specific and damaging agents remains lows.	1. Gap analysis of previous survey efforts and further delimitation of native ranges, potentially leading to further searches in Asia and the USA (and possibly southern Africa). This would include taxonomic work to confirm the species we have in Australia, and to help delimit their native ranges.
Themeda quadrivalvis	Grazing management not dictated by weed (through reduced competitiveness)	Low	Poorly studied species but, in the absence of further study, expect it to be a difficult target.	1. Nominate as target. 2. Conduct review of available information, and prioritise actions for a biocontrol program.
Ulex europaeus	Prevent it from forming extensive, dense infestations that will cause lost production and seriously impact property management. Make it affordable to manage using existing chemical and mechanical control tools. Slow the spread to other areas by reducing seed outputs.	Low	All possible available agents have already been released and having some impact, although spread has been slow for some.	No actions identified.
Vachellia nilotica ssp. *indica* (syn *Acacia nilotica* ssp. *indica*)	Improve livestock carrying capacity in invaded grasslands by reducing cover (primarily in Mitchell grasslands in QLD). Reduce control costs and increase ability to prevent spread across potential range.	Low-Mod	Only three remaining potential agents, all leaf-feeders of unknown host-specificity which currently can't be cultured. Impact will probably require high levels of prolonged defoliation.	1. Finalise testing of 3 remaining potential insects, and follow through if expected to cause required impact and are safe. 2. Critically assess past exploration/testing work to determine whether other options are available.
Vulpia spp.	Grazing management is not dictated by weed (through reduced competitiveness), thus improving farm management operations.	Unfeasible	Unsuitable for classical biocontrol. Desirable fodder at some times of the year.	No actions identified.

Xanthium occidentale (syn *X. strumarium*)	Improve farm management operations (livestock movement) by reducing patch size, population density and biomass. Reduce the need and/or frequency of other weed management tactics by lowering recruitment of the weed.	Low	There are limited options to enhance biocontrol of this weed, especially because of its ephemeral nature. New agents or rust strains would need to be well adapted to hot/dry climates where biocontrol is not currently effective.	1. Carry out a survey in Central and South America to identify new potential agents.
Xanthium spinosum	Improve farm management operations (livestock movement) by reducing patch size, population density and biomass. Reduce the need and/or frequency of other weed management tactics by lowering recruitment of the weed.	Low	There are limited options to enhance biocontrol of this weed considering the amount of efforts that have already been expanded.	1. Collect stem-borer and stem-miner insects found in Argentina and Chile in the 1990s. 2. Perform preliminary host-specificity tests, especially on sunflower, to determine if they have any potential for biocontrol.
Ziziphus mauritiana	Improve livestock carrying capacity through reduced density. Make management through other means more achievable (including through preventing re-establishment following control work). Slow the spread into unaffected at-risk areas.	Low-Mod	A largely unexplored target. Expect to find potential agents, but too early to properly assess likelihood of success.	1. Assess whether biocontrol is better than diligent targeting of large-seeding trees. 2. Assess potential for targeting biocontrol to reduce seed production.

7.8 Appendix 8

Feasibility and likelihood of success of biocontrol with new agents for the weeds assessed through the prioritisation framework.

Weed taxa	Feasibility of biocontrol		Likelihood of success of biocontrol	
	Rank	**Rationale**	**Rank**	**Rationale**
Andropogon gayanus	Low	Potential resistance to BC still needs to be assessed and if possible resolved. No known host specialists, although specific searches have not been made. Feasibility would increase once approved as a target for BC, and subject to results from preliminary native-range work.	Low	Ranked as low on the basis that grasses have historically been difficult targets, and on the lack of knowledge about the plant and its natural enemies in its native range. However, its' ecology, and early success on a structually similar high biomass grass (*Arundo donax*) suggests it may nonetheless be promising target.
Arctotheca calendula	Low	A desirable pasture plant for farmers in WA, so likelihood of undertaking biocontrol limited because of expected opposition. Good potential agents known, likely to be host-specific. However, to overcome possible conflict with those who value it, agent(s) will need to be specific toward the putatively different weedy form found in eastern Australia.	Mod	Unlikely that damage will occur early enough in the growing season to prevent seeding. Damage that reduces competitive ability would be required every year since it is annual species with long-lived seed.
Asphodelus fistulosus	Mod	Nomination as a target for biocontrol will remain a challenge until more data on its impact are gathered. Good prospect to find a host-specific rust strain since it did not infect a congener species in preliminary testing. No other known potential agents, although comprehensive surveys have not been performed.	Mod	Rust fungus may cause sufficient damage on plants in the field to sufficiently reduce competitiveness, but may not be effective across all climatic conditions where the weed occurs.
Bryophyllum delagoense	Low	Two weevils impact important nursery species and their release is therefore dependent on a Benefit-Cost Analysis and use of the Biological Control Act. Unlikely to find further host-specific agents.	Mod	Stem-borers are expected to be able to cause the required damage, provided they reach sufficient densities across the at-risk area.
Calotropis procera	Mod	Based on existing known agents, and the avenues for finding more, although native-range still needs to be properly delimited (through taxonomic work) and may include inaccessible regions.	Mod	No reason to believe that it will be a particularly difficult target provided more potential agents can be found. Low likelihood if only multi-voltine seed/fruit feeders are available as they have a poor track record on their own for perennials. The climatic diversity of the target region (northern Australia) may necessitate multiple agents.
Carduus nutans	Low	No new agents expected to be found in the native range that could enhance existing biocontrol.	Low	Biocontrol program established many years ago and indications are that it is having a major impact.
Carduus tenuiflorus and *C. pycnocephalus*	Low	Candidate insect agents have been identified but all are already known to attack other Cardueae (artichoke and native species) and thus there are no options unless more specific insect biotypes are found.	High	Based on success observed with *C. nutans*, rosette-feeding insect agents could potentially have a high impact on growth and competitiveness of the weed, especially if combined with pasture competition.
Carthamus lanatus	Low	Comprehensive surveying across native range	Mod	Plants can easily compensate for damage, so level of attack

		completed, and only one candidate agent, the rosette crown-feeding fly, found to be sufficiently specific (i.e. no attack on safflower). Limited prospect to find other agents that do not affect safflower.		on rosettes would need to be high. Uncertainty about the ability of rosette crown-feeding fly to cause sufficient damage to reduce populations of the weed.
Cenchrus pedicellatus and *C. polystachios*	Low	Limited knowledge, low expectation of potential agents that are sufficiently host specific.	Low	Nothing to suggest that it will be an easier target then other grasses
Chromolaena odorata	High	At least several host-specific agents known through biocontrol programs conducted by other countries.	High	Effective biocontrol in other countries on the same genotype and in similar environments suggests it will also be effective in Australia.
Cirsium arvense	High	Of the extensive number of natural enemies found on this weed in the native range, there are chances that additional agents sufficiently host-specific for the Australian situation could be found, especially considering precedents with *Carduus* and *Onopordum* spp. Pathogen survey currently being undertaken may reveal promising candidate, although note that the rust fungus that attacks this weed is already present in Australia.	Low	Considering the extensive work done on the biocontrol of this weed and the poor track record of agents released/established in other countries for this weed, which included a stem miner (although no crown/root feeder were ever released), it is legitimate to conclude that it is a difficult target and chances of achieving successful biocontrol are low.
Cirsium vulgare	Mod	Of the extensive number of natural enemies found on this weed in the native range, there are chances that additional agents sufficiently host-specific for the Australian situation could be found, especially considering precedents with *Carduus* and *Onopordum* spp.	High	Still missing a key agent in the suite released that would attack the crown/root of the weed (seed feeders will not do the job alone). Based on success observed with other thistles, rosette-feeding insect agents could potentially have a high impact on growth and competitiveness of the weed, especially if combined with pasture competition.
Cryptostegia grandiflora	Low	Already comprehensively surveyed. Wouldn't expect to find additional host-specific agents.	Low	Low based on impacts of existing agents, and lack of further host-specific agents. Assessment might change if further potential agents are discovered, and what they were.
Cytisus scoparius	Low	Comprehensive surveying for natural enemies across native range completed and all available suitable agents have been released in Australia. New Zealand introduced two additional insect agents, but it is unlikely that they would ever get approval for release in Australia because they can attack tagasaste, a valuable fodder crop used in WA.	Low	Some prospect to enhance biocontrol by introducing additional agents, although the long-lived seedbank and rapid recruitment following stand density reduction, strongly indicate that an integrated weed management approach may be more successful at achieving goals.
Echium plantagineum	Low	No new agents expected to be found in the native range that could enhance existing biocontrol.	Low	Biocontrol program established many years ago and indications is that it is having a major impact.
Emex australis	Low	Comprehensive surveying of arthropods across native range completed and most options have been investigated. There remains two candidate agents. The weevil *Perapion neofallax* is promising because of its ability to diapause over summer when the weed is not growing in Australia, but major difficulties in rearing it have been encountered in the past. A *Cercospora* leaf	Low	Weed is able to tolerate extensive damage and still produce seed. It is already being attacked by two natural enemies across its range without providing control. Additional candidate agents have attributes (diapause, spores) that might favour establishment, although their potential impact on the weed is unknown.

		pathogen could also be considered for use in biocontrol.		
Eragrostis curvula	Unfeasible	Unfeasible biocontrol target as species can be both problematic and useful as a pasture, depending on setting and cultivar.	n/a	n/a
Euphorbia terracina	Mod	Limited knowledge of natural enemies in native range as no surveys have been performed. There are records of the rust *Melampsora euphorbiae* infecting this weed in the native range. Good prospect to find a rust strain that would not pose a threat to Australian native *Euphorbia* spp.	Mod	High level of defoliation would be required since the plant is a long-lived perennial with a basal crown.
Harrisia martinii	Low	Further agents not expected to be found.	Low	Low in the absence of knowledge about further agents.
Hordeum spp.	Unfeasible	Desirable fodder at some times of the year. Closely-related to barley crop and therefore it would never be endorsed as a candidate for classical biocontrol.	n/a	n/a
Hyparrhenia hirta	Low	A poorly studied, unsurveyed, grass species that is expected to have a relatively depauperate fauna.	Low	A poorly studied grass species that is expected to be relatively resilient to herbivory and damage.
Hypericum perforatum	Low	Comprehensive surveying of arthropods across native range completed and all options have been investigated. There may be potential specific pathogen agents in the native range that have been overlooked during arthropod surveys. Candidate pathogen agents would need to infect all forms of the weed present in Australia.	Low	A difficult target considering that it is still a problem in parts of its range despite the large number of agents that have been released. Asynchrony between agents and the weed and/or sub-optimal climatic conditions for agent development may be important factors. Low prospect to find highly damaging and widespread pathogens in the native range, because one would expect that they would have been noticed during the extensive surveys performed over the years.
Jatropha gossypiifolia	Low	Host-testing of rust still to be completed. Otherwise, there are no known potential agents despite comprehensive surveying. Long shot opportunities on congeners and likely introduced range of this weed in South America.	Mod	Rusts have a track record of being highly effective, although it will have to perform well across diverse climates and genotypes. Likelihood becomes low in the absence of knowledge about further agents.
Lantana camara	High	Additional host-specific agents already being studied in South Africa. Further potential agents could potentially be found through targeted searching based on modern taxonomy and an analysis of past survey effort.	Low	Precedence (in Australia and elsewhere) suggests that lantana is a very challenging target, and that the types of agents that are most likely to regulate populations are few.
Lantana montevidensis	High	Relatively poorly surveyed, but would expect to find a diverse fauna, including potentially host-specific species.	Low	Low based on precedence from *Lantana camara*, but this species does not have hybrid problems that *L. camara* has. Very high degree of uncertainty due to lack of knowledge. However, agents would need to be able to cope with long drought conditions.
Lycium ferocissimum	Mod	Limited knowledge of natural enemies in native range as no surveys have been performed, although fauna expected to be large. There are records of the rust *Puccinia rapipes* infecting the weed in the native range. Good prospect to find a rust strain that would not pose a threat to the Australian native *Lycium australe*. It is	Mod	A hardy target, but reasons to believe that agents could be found that will help meet biocontrol goals. Would require extensive defoliation over several years to reduce density and biomass of infestations.

		unknown if Insect natural enemies would have the required specificity.		
Marrubium vulgare	High	Comprehensive surveying for arthropod natural enemies across native range completed. Three insect species (Cerambycid, Nitidulid and Butterfly) with potential for biocontrol have already been identified and have good chances of being host-specific (considering there are no closely-related native and economic species to *M. vulgare* in Australia), but difficulties were encountered in the past to establish colonies of these species. There may be potential pathogen agents in the native range that have been overlooked during arthropod surveys, although highly damaging and widespread pathogens on the weed would more than likely have been noticed during these surveys if present.	Mod	Field observations made on the first two agents released, indicate that the weed is sensitive to herbivory and can be severely impacted on if climatic conditions are suitable. Prospect to enhance biocontrol efficacy with new agents are promising, especially if they are active in areas where current agents are not.
Mimosa pigra	Low	Comprehensively surveyed across native-range. Further potential agents not expected.	Low	It is a relatively tough biocontrol target and environment. Low in the absence of knowledge about further potential agents.
Moraea flaccida and *M. miniata*	Mod	Rust fungus identified in previous surveys as most promising biocontrol agent. However, because of the extreme specificity of the rust, several strains may be required to attack all putative genotypes of Cape tulips present in Australia.	Mod	Rust fungus is the most likely organism to be developed for biocontrol - severe infections have been seen in some instances in South Africa. Conditions during winter when plants grow are conducive to development of rust epidemics. High defoliation of plants is required to prevent reshooting from corms, although lower levels may be adequate when pasture competition is considered.
Nassella neesiana	Mod	All possible candidate pathogen agents have probably be found considering the surveying efforts, albeit not across the entire range, over many years. There are still opportunities to identify host-specific strains in the two rust fungi that have not been fully investigated.	Low	Grass expected to be resilient to defoliation by natural enemies. Severe infection by one or more pathogen agents over several years would be required to reduce density and biomass of infestations and seed outputs.
Nassella trichotoma	Low	Prospects of finding additional candidate pathogen agents that are host-specific are limited, considering that the areas where the weed is most common in Argentina have been surveyed several times over many years.	Low	Grass expected to be resilient to defoliation by natural enemies. Severe infection by one or more pathogen agents over several years would be required to reduce density and biomass of infestations and seed outputs.
Onopordum spp.	Low	No new agents expected to be found in the native range that could enhance existing biocontrol.	Low	Biocontrol program established many years ago and believed to be having an impact on stemmed *Onopordum* spp. but never quantified.
Opuntia & *Cylindropuntia* spp.	High	Further host-specific agents are expected to be relatively easily found for most target species, once their taxonomy has been clarified.	Mod	Good precedent for effective control, including against some species that have already been targeted in Australia. Great opportunities presented by new knowledge on potential agents. However, breadth of target species and geographic regions do pose challenges.
Parkinsonia aculeata	Low	Comprehensive surveying across native range completed, and finding further potential agents is	Low	Lack of apparently damaging agents in the native range. Challenging ecology for a target, especially given lack of

		considered unlikely after the release of the two existing Geometrid species.		apparently damaging agents in the native range, although there is potential for synergies with "dieback", and management goals are not onerous.
Parthenium hysterophorus	Low	No real opportunities identified for finding more potential agents.	Low	Low based on absence of potential agents. Precedence suggests that effective biocontrol is possible, although it remains a relatively difficult target.
Phyla canescens	Low	Few prospects for finding host-specific agents.	Low	Expected to be a challenging biocontrol target that spreads both clonally and by seed. Only one potentially damaging natural enemy known, and it hasn't been relocated.
Physalis viscosa	Low	No known host specialists, although specific searches in the native range have not been made. Feasibility may increase once results from preliminary surveys in native range are obtained.	Mod	Severe and continuous defoliation on the related weed *Solanum elaeagnifolium* in South Africa has been shown to have a major impact, even though it has an extensive root system like *P. viscosa*. On this basis, it may be possible to find sufficiently damaging agents.
Prosopis spp.	High	Expect to find diverse range of sufficiently host-specific, culturable organisms relatively easily.	Mod	A hardy host, but reasons to believe that additional agents could be found that will help meet biocontrol goals.
Raphanus raphanistrum	Low	Even if additional areas in native range are surveyed, there is limited prospect of finding host-specific agents as the weed is very closely-related to edible radish. Pathogen agents may be the only option for host-specificity.	Low	Weed known for its ability to compensate when damaged and thus would require highly damaging agents.
Reseda lutea	Low	Considering previous work, there are few options remaining to identify host-specific agents among the limited number of natural enemies.	Low	Of all identified natural enemies, only seed-feeders remain as a possibility. They are however, unlikely to provide the necessary control to achieve the goal of biocontrol.
Romulea rosea	Low	Natural enemies mostly unknown as the weed has not been surveyed in the native range, but fauna expect to be limited. However, good prospect of finding a host-specific agent since there is no Australian native species in the same genus. A rust fungus is recorded on it in the native range, although it is also known to infect three other species in the Iridaceae, so a pathotype specific to *Romulea* spp. would have to be found.	Mod	Known to be sensitive to defoliation (it has few leaves), so pending a damaging agent is found that can oversummer when the weed is dormant, biocontrol has good chances of being successful.
Rosa rubiginosa	Low	Considering the number of closely-related species, especially in the *Rosa* genus, it is very unlikely that sufficiently host-specific agents could be found, unless pathogens like rust fungi are investigated.	Low	A hardy host that would likely require a suite of damaging agents to reduce density of infestations.
Rubus fruticosus agg. (primarily *R. anglocandicans*)	Low	Considering previous extensive work, the possibility of finding new host-specific agents in areas that have not been surveyed in Europe is low.	Low	Hardy target with limited prospect of finding new agents that would cause extensive defoliation over several years and/or attack crowns to significantly reduce density and biomass of infestations.
Senecio jacobaea	Low	No new agents expected to be found in the native range that could enhance existing biocontrol.	Low	Biocontrol program established many years ago and indications is that it is having a major impact.

Senecio madagascariensis	Low	Prospect of finding host-specific agents is low as the weed is very closely-related to Australian native *Senecio* spp. Pathogen agents may be the only option.	Low	Weed already being attacked by natural enemies of native *Senecio* spp. and seems to be tolerant of quite a lot of damage.
Senna obtusifolia	Low	Likely to find further *Senna* specialists, but finding sufficiently host-specific insects for Australia seems unlikely.	Low	Low based on absence of potential agents.
Solanum elaeagnifolium	Low	There are some prospects of finding highly host-specific insect agents considering the rich fauna in the native range and preliminary assessments undertaken. However, priority should be given to potential agents known to be highly-specific such as mites and fungal pathogens. Surveys in unexplored regions of Argentina and Chile may reveal additional candidate agents.	Mod	Evidence from South Africa that severe and continuous defoliation can have a major impact on the weed, even though it has an extensive root system. On this basis, it may be possible to find sufficiently damaging agents.
Sporobulus spp.	Low	Relatively well surveyed. High host-specificity requirements that have not yet been met.	Low	Expected to be difficult to find sufficiently damaging agents, based on previous work on *Sporobulus*, as well as on *Nasella*.
Themeda quadrivalvis	Low	Poorly studied in its native range, but expect natural enemies to be depauperate.	Low	Expected to be difficult to find sufficiently damaging agents based on precedence of other grasses.
Ulex europaeus	Low	No new agents expected to be found in the native range that could enhance existing biocontrol.	Low	Few prospects to find new agents capable of causing major damage, since all options have been investigated.
Vachellia nilotica ssp. *indica* (syn *Acacia nilotica* ssp. *indica*)	Mod	Native range now comprehensively surveyed. Only three more potential agents (of unknown host-specificity and unable to be reared). Further survey work not expected to yield additional agents.	Low	Would generally be considered to be a difficult target and existing agents have failed to reach high densities across the climatic range. Impact of remaining potential agents is not known, but would require high levels of prolonged attack.
Vulpia spp.	Unfeasible	Because of its palatability when young, it is most likely that a conflict would occur should this species be proposed as a biocontrol target.	n/a	n/a
Xanthium occidentale (syn *X. strumarium*)	Low	All known, host-specific insect agents from USA and Mexico have already been released. Additional agents may be found in other regions of Central and South America since they have been unexplored. It will remain a challenge to find compatible rust genotypes better adapted to hot/dry climates to enhance biocontrol in areas where the rust is currently not effective in Australia.	Low	Few prospects to find suitable new agents. Defoliation and stem attack prior to flowering has been shown to be efficient in reducing populations. Weed is often ephemeral along water courses and this has been one of the problems for populations of agents to sustain themselves.
Xanthium spinosum	Low	Considering previous work, the possibility of finding new agents not previously considered is low. Stem-borer and stem-miner insects found in Argentina and Chile in the 1990s that have not been investigated may have potential, although may be found not to be sufficiently host-specific.	Low	Few prospects to find new agents capable of causing major damage since most options have been investigated. Defoliation only, without stem attack, would not be sufficient to control plants unless they are associated with a vigorous pasture.
Ziziphus mauritiana	Mod	Expect a relatively rich fauna, although may have trouble with host-specificity requirements.	Low	Expected to be a difficult target, although reducing spread rates is a relatively modest objective. Likelihood of success might increase subject to results from targeted surveys.

7.9 Appendix 9

If a copy of the Excel file (Biocontrol target prioritisation master file final-1 Nov 2013) is required please email Cameron Allan callan@mla.com.au

SUMMARY WORKSHEET

Taxa	**Common name**	**Climate zone**	**Current impact** (Negligible, low, moderate, high)	**Current impact rationale** (add comment to provide justification for impact category chosen)	**Potential impact** (Negligible, low, moderate, high)	**Potential impact range** (to capture uncertainty)	**Potential impact rationale** (include key assumptions)	**Inclusion in biocontrol assessment** (yes, combined or no; no is selected when weed has Negligible current and potential impact)	**Currently or previously targeted by a biocontrol research in Australia and/or elsewhere** (yes/no)
Andropogon gayanus	Gamba grass	N	Low	It can form extensive monocultures in major soil types/habitats across the savannas. It was introduced and promoted as a pasture grass and can be beneficial in limited well-managed situations. However, it is not palatable once tall, potentially reducing carrying capacities. More importantly, high, late-curing biomass can result in increased numbers of extreme and catastrophic fire danger days. Extreme fires can pose serious threats to pastoral enterprises, and can greatly alter fire management options. Most serious impacts are still restricted, including in relatively small pastoral properties around Batchelor, NT.	Mod	Low-High	It has the potential to become dense across much of the higher-rainfall savannas, including in well-managed grasslands and woodlands. Increased fire risks from rank, high-biomass grass are expected to cause challenges for managing pastoral properties. It may also reduce pasture potential, although that has not yet quantified.	Yes	No
Arctotheca calendula	Capeweed	S	Low	Very widespread, mostly in temperate and sub-tropical regions, and sometimes dominant in pasture, especially in south west WA. Palatable to stock and has good similar crude protein and carbohydrate to clovers and grasses from autumn to spring. Nitrate poisoning of stock is possible though. Often predominant around stock camps. Can grow quickly in warm weather and displace sown pasture species. Spray grazing, spray topping and pasture topping can be used to keep levels low but are detrimental to subclover pasture.	Low	Low-Mod	Already very widespread so not expected to change except is localised areas, e.g. in Tas, Riverina Region NSW. Stolon forming populations in eastern States need investigation because of perception of increasing impact. However, overall impact on enterprises unlikely to change, unless subjected to extended period of poor management or severe drought.	Yes	Yes
Asphodelus fistulosus	Onion weed	S	Low	Widespread in semi-arid to subhumid warm-temperate regions. Generally associated with overgrazed pastures; does not dominate in well maintained pastures. Once established it is quite drought-hardy. It can grow very thickly and reduce other vegetation. Not palatable to stock.	Low	Low-Mod	Providing adequate pasture management is undertaken, enterprise-level production losses are not likely to increase.	Yes	Yes
Bryophyllum delagoense	Mother of Millions	N	Low	Causes poisoning if sufficient is eaten by naïve livestock. Can have serious implications for managing stock within properties (the loss of up to 140 head of cattle has been reported), and for movement/sale of naïve stock into infested areas. Widespread in throughout QLD, including Western Downs and Ipswich hinterland where it can be problematic. Becoming more widespread in NSW where it is problematic around Moree and Narrabri. Typically has restricted distributions within properties, favouring high disturbance areas such as roadsides and creek lines. It is unclear whether it is an inconvenience to some, or a much more serious and widespread problem than that. Ranked as low, but could be actually be moderate, especially if stock losses are under-reported.	Mod	Neg-Mod	Anecdotal observations suggest is it is becoming more widespread and abundant.	Yes	Yes

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Calotropis procera	Calotrope	N	Low	It is widespread across the savannas, but is a poor competitor, generally only becoming dense under high disturbance such as around watering points and following scrub-clearing. As a consequence dense infestations within properties are of limited extent. An exclosure study in the VRD also suggests dense populations can naturally decline. It is not thorny or toxic, and can be a browsed under some circumstances.	Low	Low-Mod	It is expected to continue to increase in extent and density under high disturbance conditions. The key questions are whether extensive, dense populations can form even across well-managed properties, and the longevity of infestations once formed.	Yes	No
Carduus nutans	Nodding thistle	S	Low	More restricted distribution than other Carduus spp. thistles. Can cause some production losses but infestations are generally localised in extent within enterprises (e.g. high nutrient and disturbed sites such as sheep camps and around stock yards). Occurs irregularly from year to year. Biocontrol program has been very effective against it.	Low	Low-Mod	Impact will continue to vary from years to years. Providing disturbance is kept to a minimum and pastures are well managed there should not be an increase in enterprise-level production losses. Its importance/relevant for grazing enterprises will be significantly reduced as biocontrol continues to be successful across the weed range.	Yes	yes
Carduus tenuiflorus and *C. pycnocephalus*	Slender thistles	S	Mod	Widespread in subhumid warm temperate regions. Weeds of improved pastures (following disturbance) and neglected areas. Can cause some production losses but infestations are generally localised in extent within enterprises (e.g. high nutrient and disturbed sites such as sheep camps and around stock yards). Occurs irregularly from year to year. Not readily grazed by stock because of spines. Heavy grazing encourages infestation. Requires a management plan persisting over a number of years. Biocontrol program has been very effective against C. nutans.	Mod	Low-Mod	Impact will continue to vary from years to years. Providing disturbance is kept to a minimum and pastures are well managed there should not be an increase in enterprise-level production losses.	Yes	Yes
Carthamus lanatus	Saffron thistle	S	Low	Very widespread in warm-temperate and sub-tropical semi-arid areas. Found in poor pastures but rarely in perennial or improved annual pastures because it doesn't withstand competition. Generally doesn't cause major production losses to well-managed livestock enterprises. Eaten when very young but has little fodder value. Dense patches can restrict stock movement. Also causes vegetable fault in wool. Heavy grazing encourages infestations. An effective control program combines cropping and pasture establishment. Spray-graze technique is effective for control.	Low	Low-Mod	Very widespread – has most likely reached all suitable habitats. More frequent droughts could exacerbate its impact on enterprises, but still it is unlikely to cause major problems beyond localised areas within enterprises.	Yes	Yes
Cenchrus longispinus and *C. incertus*	Innocent weed	S	Neg	Mainly found in the east in temperate subhumid and semi arid regions. Does not establish readily in pastures. Palatable to stock. Burrs are the main problem; they become badly tangled in wool, lowering its value and making sheep difficult to handle. No evidence of enterprise-level impacts. Preventing seeding is the key to successful control. This can be achieved with heavy sheep grazing in infested area.	Neg	Neg-Low	Unlikely to change, unlike increase in land use for wool production.	No	No
Cenchrus pedicellatus and *C. polystachios*	Annual and perennial mission grasses	N	Neg	Ranked as high impact environment weed as it can invade natural bushland resulting in continuous cover beneath an intact canopy. It is unpalatable. However, no examples were found of it causing serious impacts in pastoral settings, certainly not at enterprise level.	Low	Neg-High	It is still early in its invasion. Further work is required to assess risks, for example to determine how competitive it is in pastoral systems.	Yes	No

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Chromolaena odorata	Siam weed	N	Neg	An unpalatable herb which is expected to compete with pastures. Eradication program only recently abandoned. Current populations still too small and few to impact production.	Mod	Neg-High	Expected to have the ability to form monocultures, at least across the high-rainfall savannas. It benefits from high disturbance. Yet to be seen how competitive it will be in well managed pastoral settings, and what its soil/moisture requirements (and therefore "ecological reach") will be.	Yes	Yes
Cirsium arvense	Californian thistle	S	Low	Restricted distribution, primarily in Vic and Tas. Confined to areas receiving more than 700mm annual rainfall and more a weed of crops than pastures. Seedling survival is poor, but once established it strongly competes with pasture and control can be difficult. Extensive and vigorous root system. Avoided by stock.	Low	Low	Impact on enterprises unlikely to change. Has probably reached all suitable habitats and further expansion in distribution unlikely under current climate.	Yes	Yes
Cirsium vulgare	Spear thistle	S	Mod	Widespread in sub-humid cool-temperate regions. Readily establishes in highly fertile soil that are bare at the end of summer (commonly occurs in annual pastures but also in overgrazed or disturbed perennial pastures). Infestations are generally localised in extent within enterprises (e.g. high nutrient and disturbed sites such as sheep camps and around stock yards). Not readily grazed by stock. Spiny nature of plants deters animals from grazing pasture in their vicinity. Large patches are impenetrable to stock. Infestations promoted in heavily grazed pastures. Levels of infestation vary from year to year. Contributes to vegetable fault of wool. Establishment of a perennial pasture is the recommended approach to control infestations.	Mod	Low-Mod	Already quite widespread – has most likely reached all suitable habitats and impacts expected to remain the same.	Yes	Yes
Cryptostegia grandiflora	Rubber vine	N	Mod	Unpalatable. It is largely restricted to riparian zones in central-north QLD. It is ranked as moderate as it forms extensive infestations in the most productive parts of many properties in central-northern QLD. However, actual, proportional enterprise-level production losses need to be better quantified to confirm this. It is not thorny or toxic. Biological control is currently partially successful.	Mod	Low-High	It has the potential to further increase its distribution, including into riparian areas in the NT and the Kimberley region of WA. However, it is still unclear how well it will perform there, and how effective existing biocontrol will be. Also, the long-term impact of the existing pathogen in C-N QLD is still to be determined: have all impacts already occurred, or will rubber vine populations continue to decline?	Yes	Yes
Cytisus scoparius	Broom	S	Low	Distributed in Moderate to high rainfall areas of humid temperate regions (especially Vic and Tas). Primarily a weed of bushland and Neglected areas. Does not establish in improved pastures unless there are bare patches. Once established dominates vegetation. Only a localised problem for grazing industry, where it can cause some production losses. Control generally relies on cut stump method and spot spraying. Biocontrol has so far been ineffective.	Mod	Low-Mod	Likely to continue to spread. Could become worse as grazing is pushed out of the high rainfall zone into more native systems, e.g. invaded uplands and hilly areas in Vic, Tas and SA.	Yes	Yes

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Diplotaxis tenuifolia	Lincoln weed	S	Neg	Distributed in warm-temperate regions of southern Australia (mainly Vic and SA). Invades poor pastures and becomes dominant, but doesn't cause problems in established, well-managed pastures. Considered by some as being valuable as fodder (formerly sown as pasture species). Grazed when in flower, otherwise it is ignored by stock. Introduction of perennial pasture species helps with its management.	Neg	Neg-Low	May potentially spread further and establish new infestations, especially in marginal land where it is difficult to maintain vigorous pastures.	No	No
Echium plantagineum	Paterson's curse	S	Mod	Very widespread in warm-temperate regions. Common weed of degraded pastures. Palatable to stock, especially sheep, prior to flowering. Contains toxins, but sheep, cattle and goats are least affected. The large, broad rosette leaves shade and smother most other species. It can cause potentially serious enterprise-level production losses, but generally not in all enterprises in all years across the broad geographical range of the weed. Sheep grazing at high stocking rates reduce the weed significantly. In contrast, it flourishes where only cattle are grazed. Spray/graze technique has proved effective for control. Biological control has shown promising signs but the agents have not yet reached high densities across the entire range of the weed to claim success.	Low	Low-Mod	Impact on enterprises may be lessen if biocontrol continue to be effective and expands into new areas.	Yes	Yes
Emex australis	Spiny emex	S	Low	Widespread in subhumid and semi-arid tropical, subtropical and temperate regions. Competes with pastures because it is fast growing and its prostrate growth smothers desirable species. Not readily eaten by stock (but poisoning of sheep has been reported). Can cause some production losses to grazing enterprises. Mainly a weed of crop-pasture rotations and tends to decline in permanent pastures. To be successful, control programs must aim at killing plants shortly after emergence and must be continued for several years.	Mod	Low-High	Likely to increase in importance with move back to pasture crop rotations.	Yes	Yes
Eragrostis curvula	African love grass	S	Mod	Widespread in semi-arid subtropical grasslands. Highly persistent, summer-growing. Without intensive management can reduce the value of pasture. Often dominate sparse, overgrazed pastures. Palatable when young, but generally ignored by stock because many other more palatable species are available in spring-early summer. Quickly loses palatability (with exception of the Consol variety, or unless carefully managed). Can be maintained in an acceptable stage by topdressing (especially N) and heavy rotational grazing. Dominance can result in reducing carrying capacity by at least 3-4 DSE. Many landholders in northern and southern Tablelands and south coast consider it to be a serious weed affecting grazing enterprises in the 1980s and it is assumed to have continued on this trajectory.	Mod	Mod-High	Little data or direct observation to support projections. Better understanding is required regarding conditions required for it become dominant, and how extensive dominant infestations could become	Yes	No

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Erodium cicutarium	Common storksbill	S	Neg	Widespread throughout temperate and Mediterranean pastures of Australia, primarily on sandy soils. May prevent establishment of perennial grasses by blocking access to light. Palatable fodder that is useful in winter and spring and therefore not considered to significantly affect enterprise production and management. However, seeds can injure stock, shearers and handlers. Can be controlled with spray-grazing, pasture manipulation and spray topping.	Neg	Neg	May be more beneficial forage under drier climates.	No	No
Euphorbia terracina	False caper	S	Low	Most abundant in coastal and inland SA and in coastal sand dunes and pastures on calcareous soils of WA, from Geraldton to south of Fremantle. Considered both an environmental and pasture weed. Toxic to stock, but generally not eaten because of its acrid milky sap. Can be a serious competitor with pasture plants and can dominate pastures on calcareous soils e.g. Greenough region in WA.	Mod	Low-Mod	Based on current distribution in SA, it has the potential to spread further into inland areas in WA, Vic and NSW. Could become an increasing problem for grazing industries in these states as number and density of infestations increase.	Yes	No
Galium tricornutum	Three-horned bedstraw	S	Neg	Only localised/small infestations in SA and NSW. Present in only five farms in WA and is an eradication target. Problem in crop-pasture rotation situation because it is competitive, has a persistent seed bank and is particularly difficult to control in crops. Seed can be spread as a contaminant of agricultural products.	Neg	Neg	May increase in importance with move back to pasture crop rotations.	No	No
Harrisia martinii	Harrisia cactus	N	Low	Based on anecdotal evidence that it is emerging as a relatively serious problem around Goondiwindi, NSW.	Low	Neg-Mod	Uncertainty regarding apparently emerging problem around Goondiwindi, NSW and the potential ability of existing biocontrol agents in managing it.	Yes	Yes
Hordeum spp.	Barley grass	S	Low	Very widespread in temperate and sub-tropical regions. Valuable fodder for early season production but avoided by stock when flowering. Seeds can cause injuries to stock and contaminate wool. Typically localised within enterprises, i.e. often associated with increasing soil fertility and can be seen in animal camp areas. Continuous grazing reduces perennial grasses and favours it, while more grazing reduces it in annual pasture systems. Any activity to stop seed set will provide good control of this weed.	Low	Neg-Low	Little data or direct observation to support projections. Better understanding is required regarding conditions required for it become dominant, and how extensive dominant infestations could become.	Yes	No

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Hyparrhenia hirta	Coolatai grass	S	Low	Locally dominant on road sides on the north western slopes of NSW and adjacent areas of QLD. Only a few other infestations across the country. Mainly a roadside and bushland weed of increasing frequency in WA. Thrives in both sub-tropical and temperate conditions. Long-lived summer active perennial grass that forms dense tussocks, up to 1.5 m. Invade pastures particularly where ground cover is low (< 70%) because of grazing regime and low soil fertility. Pastures dominated by it can be productive, although the management requirements are higher than that commonly employed (i.e. it needs to be kept short to meet feed requirement of dry stock). Has resulted in widespread changes in pastoral practice in affected areas, including through altered grazing management practices. "Coolatai grass presents a dilemma in that it is able to invade relatively undisturbed natural ecosystems, yet can be a resilient productive pasture species if managed correctly." http://www.dpi.nsw.gov.au/agriculture/pests-weeds/weeds/profiles/coolatai	Mod	Low-Mod	High likelihood that it will continue to expand its range in southern Australia. More easily managed perennial and annual pasture options are preferable to this grass.	Yes	No
Hypericum perforatum	St. John's wort	S	Mod	Widespread in humid and subhumid temperate regions, especially in Vic and NSW. Of minor importance in WA. Primarily invades poorly managed grazing land. Eaten by stock when other feed is scarce. Poisonous to stock not accustomed to it. Competes throughout the year with other species. Infestations are encouraged by heavy grazing. Pasture improvements following high defoliation by biological control agents (*Chrysolina* beetles) can be effective in some years, but not in all habitats, particularly in open woodland grazing systems. If grazing is carefully managed it will not cause serious enterprise-level production losses.	Low	Low-Mod	Expected to have the same impact as currently, unless its range increases in drier climates unsuitable for existing biocontrol agents.	Yes	Yes
Hypochaeris spp.	Cat's ear	S	Neg	Common and widespread in NSW, Tas, ACT, Vic and south-eastern SA and south-western WA. Common in south-eastern QLD. Can become dominant where there is regular soil disturbance. Also dominates in situations of regular mowing and soil compaction. Rosettes can cover a relatively large area of soil and preclude recruitment by desirable species. Palatable to stock. Rotational grazing reduces infestations by encouraging grasses. Perennial pastures are more resilient to infestation. Mostly a nuisance weed that does not significantly affect production currently.	Neg	Neg-Low	Already widespread. Infestations could potentially increase in density in marginal grazing land.	No	No
Hyptis suaveolons	Hyptis	N	Neg	Unpalatable. A symptom of poor grazing management. Restricted in reach.	Neg	Neg-Low	Dense infestations are expected to remain restricted, and largely preventable through property management practices. Are invasions reversible?	No	Yes

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Jatropha gossypiifolia	Bellyache bush	N	Low	Unpalatable. Forms extensive monocultures across major soil types/habitats across savannas, replacing palatable pastures. Difficult to manage, including through pasture management. Although widely distributed it is not yet thought to be causing serious enterprise-level impacts or, if it is, then serious impacts are limited to relatively few properties nationally.	Mod	Low-High	High based on expectations that it has the ability to form extensive monocultures in diverse environments (including uplands) across large parts of the savannas. It is not yet clear what grazing management or disturbance regimes are required for monocultures to occur. It remains costly to control. Naturally-occurring dieback is being reported in QLD.	Yes	Yes
Lantana camara	Lantana	W	High	Toxic (to newly exposed livestock), competes with pasture, and interferes with mustering. A serious problem in wetter coastal zones from north QLD to northern NSW, has a wide ecological reach (open, woodlands, riparian), and is expensive and difficult to manage with existing options. Enterprise impacts are substantial at a regional scale.	High	Mod-High	Expected to continue to worsen (although land use is changing in at least some at-risk areas)	Yes	Yes
Lantana montevidensis	Creeping lantana	N	Neg	Weed is widespread from Gladstone south through Monto, Blackbutt and through to Ipswich. It can take over paddocks, typically after prolonged drought, decreasing production. It is difficult to control. Greatest impacts are thought to occur in the Monto Region. Further information on impacts is required if this species is to be upgraded to Low or Moderate.	Low	Neg-Mod	Weed may spread to other regions. Less common in wetter regions. Need more information.	Yes	Yes
Lycium ferocissimum	African boxthorn	S	Mod	Found throughout NSW, particularly in the western pastoral areas, and in Vic (worst infestations in the north). Established over large areas in northern marginal land in SA and occurs along most of the south west WA coast and hinterland. Creates impenetrable barriers to livestock, reducing access to pasture and water sources. Seldom grazed because of its sharp spines. Effective control requires the integration of a number of control methods and is thus costly – primarily chemical and physical means - with regular follow-ups. In contrast to gorse, it can produce flowers and seeds on old wood, a characteristic that enhances it capacity to spread.	Mod	Mod-High	High likelihood of infilling within its range in southern Australia, thus affecting more enterprises.	Yes	No

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Marrubium vulgare	Horehound	S	Low	Widespread, mostly in SA, NSW and Vic. Typically localised in extent in enterprises (e.g. around sheep camps), but can also invades pastures under favourable conditions (e.g. following drought). Seedlings however, do not establish in dense pastures. Not palatable to stock and thus infestations are encouraged by heavy grazing that reduce desirable pasture species. Relatively drought tolerant and will grow in very poor soil. Causes vegetable fault in wool. Biocontrol has shown promising signs but the agents have not yet reached high densities across the entire range of the weed to claim success.	Low	Neg-Low	Its importance/relevant for grazing enterprises may be significantly reduced if the biocontrol is successful across the weed range.	Yes	Yes
Mimosa diplotricha var. *diplotricha* (syn. *Mimosa invisa*)	Creeping sensitive plant	N	Neg	Weed is not considered a major problem. It is under effective control by a psyllid biocontrol agent. New infestations can be managed through redistribution of the psyllid. It is unlikely to be considered a major problem.	Neg	Neg-Low	No reason for status to change into the future.	No	Yes
Mimosa pigra	Mimosa; Giant sensitive plant	N	Low	Forms extensive, permanent monocultures in wetlands in the Top End, NT replacing valuable pasture. It can do so in even relatively well managed properties (due in part to disturbance by feral animals). It is expensive to manage. It severely affects relatively few properties across the Top End, NT, and only a proportion of the wetlands of those that are heavily invaded. Biocontrol has made it easier to manage.	Low	Low	High density infestations could increase where habitat is suitable (including the VRD and east Kimberley, WA, if containment is unsuccessful). Potential impact has been greatly reduced through biocontrol. Future impact is also dependent in part on the long term effects of dieback, which appears to be becoming more common, and the long-term future of feral animal management. Pastoral impacts will always be largely restricted to properties with high dependence on extensive wetlands.	Yes	Yes
Moraea flaccida and *M. miniata*	one and two-leaf Cape tulips	S	Mod	Both species occur in grazing land in southern Australia, especially in SA and WA, although *M. miniata* affect fewer enterprises across the range. Poisonous to stock, with cattle more susceptible than sheep. Avoidance of the weed by grazing animals contributes to its persistence. Where the problem is severe, farmers have had to abandon running stock on their properties, in particular in organic farming. Dormancy in corms makes control very difficult and means that methods must be applied at the right time and for several successive years (at least 4 yrs).	Mod	Mod-High	It may become prohibitive to manage heavy infestations, especially of *M. flaccida*, with current methods and more farmers may decide to opt out of livestock production altogether. *M. miniata* may expand its range over time and affect more enterprises.	Yes	yes

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Nassella neesiana	Chilean needle grass	S	Mod	Scattered infestations in NSW and Vic. Palatable and considered to be a reasonable feed in winter but a poor feed when flowering and seeding. Causes vegetable fault in wool. Tolerates drought and heavy grazing. Vigorous and competitive against desirable pasture species. For best control a combination of methods is required (pasture sowing, herbicide and grazing management). Needs bare ground to establish so important to maintain good pasture cover.	Mod	Mod-High	Spreading fast through NSW and will become an increasingly poor quality competitive grass in grazing systems. However, better understanding is required regarding conditions required for it become dominant, and how extensive dominant infestations could become.	Yes	Yes
Nassella trichotoma	Serrated tussock	S	Mod	Distribution restricted to NSW and Vic. Found in open pastures and relatively resistant to drought. Eaten by cattle and sheep if nothing else is present, but animal are unable to digest it. Causes vegetable fault in wool. Even Moderate infestations can reduce carrying capacity by about 40%. Heavy grazing favours its persistence and spread. Seedlings cannot withstand strong pasture competition. Combination of cultivation and/or herbicide with pasture improvements (e.g. top dressing and sowing) and careful grazing management are necessary to effectively control it.	Mod	Mod-High	Still spreading and infilling. Least palatable grass weeds in the South East. Better understanding is required regarding conditions required for it become dominant, and how extensive dominant infestations could become.	Yes	Yes
Onopordum spp.	Onopordum thistles	S	Mod	Found in subhumid and warm-temperate regions of southern Australia in pastures of reasonable fertility. Often establishes where pasture improvement has been attempted. Not eaten by stock. Incidence varies from year to year. Generally localised in extent within an enterprise (e.g. high soil fertility in animal camps favours establishment and growth). Competes well with pasture species in high rainfall areas. Dense patches hindered stock movement. Best ways to contain infestations is to combine cultivation, establishment of highly competitive pasture species and some herbicide spraying. Grazing of flowering plants by goats and to a lesser extent cattle can lead to a worthwhile reduction in seed production. Good biocontrol agents have been released and are still spreading.	Low	Low-Mod	Likely to continue to spread and affect more enterprises, but biocontrol agents should be able to stay on top of it and reduce populations and seed outputs.	Yes	Yes
Opuntia & *Cylindropuntia* spp.	Opuntioid cacti (as a group)	W	Low	Approximately 30 invasive species in this group in Australia which includes the spiny, vegetatively propagating Cylindropuntia and the mainly fruit-propagating Opuntia. Cylindropuntia spp. together with the other Opuntioid cacti present a threat to grazing industries through their ability to form dense infestations that can reduce access to feed and hinder mustering activities. Their spines can injure stock, damage fleece and hides and affect the safe handling of affected animals for shearing purposes. Stock does not generally feed on cacti. Their confined distributions are still relatively restricted.	Mod	Low-High	Low productivity land is at greatest risk. The expectation is that infestations, and impact, will become much worse. Depending on the location and density of an infestation, the cost of control may outweigh the economic value of the land. This can influence people's motivation to manage these plants, even if their impacts are known and understood. Great uncertainty regarding potential threat owing to lack of knowledge of existing infestations, and causes of invasions.	Yes	Yes

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Cylindropuntia aurantica	Tiger pear		Neg	Little information found on current extent of infestations. Qld, NSW, Vic, SA. Occurs throughout NSW (200 000 ha infested); southern QLD, Vic and SA.	Mod	Low-High	No specific information found. Great uncertainty regarding potential threat owing to lack of knowledge of existing infestations, and causes of invasions.	combined	Yes
Cylindropuntia fulgida	Coral cactus		Neg	No information found on current extent of infestations. Qld, NSW and WA Goldfields.	Mod	Low-High	No specific information found. Great uncertainty regarding potential threat owing to lack of knowledge of existing infestations, and causes of invasions.	combined	No
Cylindropuntia imbricata	Devils rope		Neg	No information found on current extent of infestations. Most common in the Lower Darling, western NSW.	Mod	Low-High	No specific information found. Great uncertainty regarding potential threat owing to lack of knowledge of existing infestations, and causes of invasions.	combined	Yes
Cylindropuntia rosea	Hudson pear		Neg	Little information found on current extent of infestations. Principally in NSW (60,000 ha found around Lightening Ridge), southeast QLD, SA, the NT and Goldfields Region, WA.	Mod	Low-High	See extensive potential distribution in the WONS Opuntioid Weed management Guide. Great uncertainty regarding potential threat owing to lack of knowledge of existing infestations, and causes of invasions.	combined	No
Cylindropuntia tunicata	Hudson pear		Neg	No information found on current extent of infestations. NSW and WA Goldfields.	Mod	Low-High	See extensive potential distribution in the WONS Opuntioid Weed management Guide. Great uncertainty regarding potential threat owing to lack of knowledge of existing infestations, and causes of invasions.	combined	Yes
Opuntia monocantha	smooth tree pear, drooping prickly pear		Neg	No information found on current extent of infestations. SA.	Mod	Low-High	No specific information found. Great uncertainty regarding potential threat owing to lack of knowledge of existing infestations, and causes of invasions.	combined	Yes
Opuntia robusta	Wheel cactus		Neg	Little information found on current extent of infestations. Occurs in Flinders Ranges (35,000 ha), in the mid-north and along the River Murray in SA, north central Vic, and southern NSW.	High	Low-High	See extensive potential distribution in the WONS Opuntioid Weed management Guide. Great uncertainty regarding potential threat owing to lack of knowledge of existing infestations, and causes of invasions.	combined	No
Parkinsonia aculeata	Parkinsonia	W	Low	Widely distributed across the northern savannas. However, extensive infestations are rare, often short-lived (15-20 yrs, in part due to dieback), and mostly restricted to seasonally or periodically flooded habitats. Extensive infestations are rare. Existing infestations are relatively easily controlled (compared to other trees), although still costly. Relatively few properties nationally with severe infestations.	Low	Neg-Mod	Is expected to continue to invade more areas. However, there is no reason to believe that the dieback phenomenon will continue to limit extent, density and longevity of infestations.	Yes	Yes

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Parthenium hysterophorus	Parthenium weed	N	Mod	Can dominate in some seasons in central QLD, but competitiveness (including size) greatly reduced through biocontrol. Poor competitor against perennial pastures. There are some doubts about whether infestations result in significant production losses, except perhaps in certain combination of seasons/years (reduced milk quality due to herds feeding on grass mixed with parthenium weed has been reported). It causes significant negative impacts on human and animal health. Extensive, dense infestations can be prevented by managing grazing and disturbance. Impacts are substantial on properties that are required to prevent spread (such as through hygiene practices, grain movement and wash-downs).	Mod	Low-High	The core infestations around central QLD are still extending into southern Qld and northern NSW. Impacts will depends in part on how well existing biocontrol agents will do in new range, and on whether parthenium will be able to compete with well managed pasture systems in those regions. Human health impacts expected to be much greater in high population areas (e.g. southeast QLD), with implications for the pastoral industry.	Yes	Yes
Phyla canescens	Lippia	S	Mod	Well adapted to the floodplain environments of river systems in temperate and subtropical regions. It has become dense across large parts of grazing/floodplain country across a significant number of livestock enterprises in upper Murray Darling, some of which relying heavily on flood-plains for pasture. May require heavy, continuous grazing to become dominant (perhaps combined with drought conditions). It has no grazing value. Causes significant losses in carrying capacity and is difficult to control once established in areas where farmers cannot or will not cultivate. It requires an integrated approach of suppression, pasture improvement and pasture maintenance to manage.	Mod	Low-Mod	Largely restricted to periodically flooded habitats in the right climate. Is likely to continue to impact more areas in more enterprises. Once established, it typically does not retreat easily.	Yes	Yes
Physalis viscosa	Prairie ground cherry	S	Low	Restricted distribution to warm-temperate regions of Vic and southern NSW. Has a deep root system similar to silver leaf nightshade, which makes control difficult when regrowth occur. Good competitor with summer crops, but becoming an increasing issues in grazing pastures in SE Australia. Cultivation is ineffective and chemical control difficult when treating regrowth from deep roots.	Mod	Mod-High	Expected to increase in importance, although a lot of uncertainty since it has remained relatively stable over the last 20 years.	Yes	No
Prosopis spp.	Mesquite	W	Low	Becomes dense in apparently well managed properties. Serious enterprise level losses through reduced carrying capacity, infrastructure maintenance, mustering, but currently only on several properties nationally. Expensive to manage.	High	Mod-High	Currently dense infestations have restricted distributions but mesquite is able to form extensive dense infestations across large areas apparently irrespective of grazing management practices. Existing control tools available but expensive. Extensive isolated to sparse infestations across large areas and many properties (mainly QLD) suggest that future impacts will be moderate to high.	Yes	Yes

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Raphanus raphanistrum	Wild radish	S	Low	Widespread in temperate regions. An important weed of cereal crops, which is also found in degraded pastures and pastures that were cropped in the past. A serious competitor that can reduce pasture yield. Unpalatable and can sometimes result in stock poisoning at high density. Maintaining a vigorous pasture with regular topdressing and light to Moderate grazing prevent infestation. It can be controlled by herbicides in a cropping phase (e.g. oats), but the emergence of herbicide resistance in this weed has become a major issue.	Low	Neg-Low	Unlikely to become a major problem since it is primarily a weed of cultivation. Can be managed by grazing and establishing permanent pasture.	Yes	Yes
Reseda lutea	Cutleaf mignonette	S	Low	Scattered distribution in temperate Australia. Mainly a weed of roadsides and waste spaces, which sometimes encroaches onto regenerating pastures, competing with desirable plants. Deep-rooted perennial that is not controlled by cultivation, grazing and mowing. Can be controlled with herbicide when young, but older plants are resistant.	Low	Low	Has potential of further spread and infilling, but unlikely to cause serious enterprise-level production losses.	Yes	Yes
Romulea rosea	Guildford grass (=onion grass)	S	Mod	Widely distributed throughout temperate and Mediterranean areas. Affects both composition and agronomic performance of pastures that are infertile and with compacted soils. Palatable but has no nutritional benefit, but causes phytobezoar (a fibrous ball that blocks the digestive system). Grazing animals can play a major role in dispersing seed. Produces both seeds and corms, which make control difficult. A regular pasture renovation program (cultivation and resowing pasture species) helps control this weed.	Mod	Low-Mod	Impact on enterprises unlikely to change. Has probably reached all suitable habitats and further expansion in distribution unlikely under current climate.	Yes	No
Rosa rubiginosa	Sweet briar	S	Low	Distributed in humid and subhumid temperate regions, mainly in eastern Australia. Young seedlings are not very competitive and few survive grazing. Not a problem in well maintained, sown pastures and therefore not consider to cause major enterprise-level production losses. Shrubs' prickly nature deters livestock from grazing close to plants. Dense patches can restrict movement to watering points.	Low	Neg-Low	Impact on enterprises unlikely to change. Has probably reached all suitable habitats and further expansion in distribution unlikely under current climate.	Yes	Yes
Rubus fruticosus agg. (primarily *R. anglocandicans*)	Blackberry	W	Mod	Widespread in southern Australia. Can restrict livestock movement and access to water courses, and reduce available grazing land. Typically localised in extent within an enterprise. Unpalatable to cattle and sheep, but eaten by goats. Rarely invades dense, well-managed pastures. Chemical treatment is the most practical method of control. Biocontrol has had some impact in reducing seed production but limited impact in reducing stand size and density, except in cool and high rainfall areas (e.g. Victorian high country).	Mod	Low-Mod	Impact on enterprises unlikely to change. Has probably reached all suitable habitats and further expansion in distribution unlikely under current climate.	Yes	Yes

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Rumex spp.	Dock	S	Neg	Widespread in cool to mildly warm temperate regions. Unpalatable to livestock, but young plants and flower stems are eaten. *R. crispus, R. pulcher* and *R. obtusifolius* can be strongly competitive in pasture. Has been regarded as the major weed of pasture in south west WA. Maintaining vigorous pasture and avoiding over-grazing help control infestations over time. Biocontrol program has been very effective across most of its range in WA.	Neg	Neg-Low	Impact on enterprises unlikely to change given successful biocontrol. Has probably reached all suitable habitats and further expansion in distribution unlikely under current climate.	No	Yes
Senecio jacobaea	Ragwort	S	Low	Present in humid temperate regions, primarily in Vic and Tas. Commonly found in poorly managed, degraded pastures, although pasture improvement alone does not control established stands. Poisonous to livestock, but selectively avoided. Biological control has been successful in most areas and has resulted in a decline in its economic impact on grazing industries in Tas. Still a sporadic problem in Vic..	Neg	Neg-Low	Impact on enterprises unlikely to change. Has probably reached all suitable habitats and further expansion in distribution unlikely under current climate.	Yes	Yes
Senecio madagascariensis	Fireweed	S	Mod	Infests primarily coastal pastures in south-eastern Australia, but is also present in the NSW tablelands and in south-east QLD. If eaten it can cause liver damage in cattle and possible death. It can be most successfully controlled with sheep and goat grazing and pasture improvement, including reduced grazing pressure or grazing rotation strategies. Farmers spend considerable time and money managing it and thus it significantly impacts on farm profitability.	Mod	Mod-High	Has potential to spread over a much broader area in southern Australia than it currently occupies.	Yes	Yes
Senna obtusifolia	Sicklepod	N	Neg	Extensive dense infestations common across northern Australia, but may primarily be restricted to highly disturbed habitats such as watering points and already heavily disturbed riparian zones. Its' main impact is perceived as pasture competition, but its reach is probably not great in most well-managed pastoral properties.	Low	Neg-Mod	There is considerable uncertainty regarding the situations under which it becomes dense. Affected areas on Cape York are not well studied. QPWS consider that it is spreading into National Parks.	Yes	Yes
Solanum elaeagnifolium	Silverleaf nightshade	S	Mod	Widespread throughout temperate Australia, except Tas. Infrequent in WA. Mainly a problem in cropping areas, but also reported to affect summer growing and annual pastures by reducing carrying capacity. It can be grazed by stock if other palatable species are absent. Cattle are more susceptible than sheep to toxins contained in plants (no death recorded in Australia though). Its extensive and interconnected root system makes control difficult and costly.	Mod	Mod-High	Likely to continue to spread and therefore has potential to significantly affect many more grazing enterprises.	Yes	Yes
Sporobulus spp.	Weedy sporobulus grasses	W	Mod	Five species currently impacting the pastoral industry. Together they already cause severe impact along the eastern seaboard, at least locally. Some species still viewed as emerging problems. Little recent information on scale of enterprise-level impacts, regional extent of impact, and to what extent problems are a function are a function of high disturbance.	Mod	Low-Mod	Little data or direct observation to support projections. Better understanding is required regarding conditions required for it become dominant, and how extensive dominant infestations could become.	Yes	yes

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Sporobolus africanus	Parramatta grass	W	Low	Dairy industry in Vic views it as a major problem, especially the northern irrigation area where it is invading high input irrigated pasture and severely reducing milk production on heavily infested properties. We couldn't confirm how serious it is in well managed enterprises across a broad geographic area, nor how easily managed it is. The implication is that it requires heavy, continuous grazing to become dominant.	Mod	Low-Mod	Little data or direct observation to support projections. Better understanding is required regarding conditions required for it become dominant, and how extensive dominant infestations could become.	combined	Yes
Sporobolus fertilis (syn *S. indicus* var. *major)*	Giant Parramatta grass	W	Mod	It is considered to cause important pastoral losses in northern NSW, although there is considerable variation in what individual people think of it (D. Officer, pers. comm. 2012). It can cause serious problems in pastures in the wetter areas on the north coast of New South Wales. It is of low palatability, completely replacing desirable pasture species, with farmers reporting 10-80% losses in carrying capacity. Cattle also take significantly longer to reach equivalent weights compared to those grazing in un-infested pastures. We couldn't confirm how serious it is in well managed enterprises across a broad geographic area, nor how easily managed it is. The implication is that it requires heavy, continuous grazing to become dominant.	Mod	Low-Mod	Little data or direct observation to support projections. Better understanding is required regarding conditions required for it become dominant, and how extensive dominant infestations could become.	combined	Yes
Sporobolus jacquemontii	American rat's tail grass	N	Low	Recognised as a serious problem in the Burdekin area of northern QLD, where it is already causing significant reductions in carrying capacity, and changed management practice, although there has been almost no research work done on this species to date. It can cause serious problems on relatively well-managed properties, although it does best in overgrazed areas. We couldn't confirm how serious it is in well managed enterprises across a broad geographic area, nor how easily managed it is. The implication is that it requires heavy, continuous grazing to become dominant.	Mod	Low-Mod	Little data or direct observation to support projections. Better understanding is required regarding conditions required for it become dominant, and how extensive dominant infestations could become.	combined	Yes
Sporobolus natalensis	Giant rat's tail grass	W	Mod	Unpalatable, can invade relatively intact pastures, and very difficult to manage once established. Greatest problems currently in coastal districts of QLD and northern new South Wales, where it has resulted in substantial reductions in stocking capacity, in cattle taking considerably longer to reach desired weights, high costs in milk production on dairy farms, high management costs, and reduced land values of highly infested lands. Anecdotal evidence suggests it can reduce the productivity of beef and dairy enterprises by half, while attempting control can incur major costs. Serious issue in western part of Atherton Tablelands, resulting in changed management practice. We couldn't confirm how serious it is in well managed enterprises across a broad geographic area, nor how easily managed it is. The implication is that it requires heavy, continuous grazing to become dominant.	Mod	Low-Mod	Little data or direct observation to support projections. Better understanding is required regarding conditions required for it become dominant, and how extensive dominant infestations could become	combined	Yes

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Sporobolus pyramidalis	Giant rat's tail grass	W	Mod	Unpalatable, can invade relatively intact pastures, and is very difficult to manage once established. Greatest problems currently in coastal QLD, where it has resulted in substantial reductions in stocking capacity, cattle taking considerably longer to reach desired weights, higher costs in milk production on dairy farms, and reduced land values of highly infested properties. Anecdotal evidence suggests it can reduce the productivity of beef and dairy enterprises by half while attempting control can incur major costs. Could not confirm how serious it is in well managed enterprises across a broad geographic area, nor how easily managed it is now.	Mod	Low-Mod	Little data or direct observation to support projections. Better understanding is required regarding conditions required for it become dominant, and how extensive dominant infestations could become	combined	Yes
Tamarix aphylla	Athel pine	W	Neg	Isolated plants found across the inland, but they rarely naturalise. A few extensive infestations (e.g. Finke River, NT and Gascoyne River, WA) demonstrate its potential to form monocultures in certain arid and semi-arid riparian systems where it could hamper stock access to water. It also has the potential to increase surface soil salinity. Not thorny or toxic. Currently restricted to very small parts of a few properties, with little or no impact on enterprise (although substantial government funds are being spent on containment and eradication). Very costly to control.	Neg	Neg-Low	Primarily of environmental concern, restricted to particular river systems. Extensive dense riparian infestations may result in altered hydrology, flooding patterns, etc. that may have serious flow on impacts for managing pastoral properties. Not likely to be a problem except in the driest areas of central southern Australia.	No	Yes
Themeda quadrivalvis	Grader grass	N	Neg	In Lakefield National Park (northern QLD) it is replacing and dominating savannah grasslands (including native perennial grasses) under relatively natural disturbance regimes where soil types are favourable. However, gaining dominance most commonly requires bare ground resulting from heavy cattle grazing or poor fire management regimes. Serious enterprise-level impacts not yet identified. Mostly viewed as an emerging problem.	Low	Neg-Mod	Expected to continue to invade when opportunities arise. It is a high biomass grass which can subsequently outcompete perennials if not managed properly, despite basically being annual. Few management options currently available beyond grazing management. Future impact will depend in part on its competitiveness on well managed enterprises.	Yes	No
Tribulus terrestris	Caltrop	W	Neg	Widespread but mainly a nuisance weed that does not significantly affect production and management of grazing enterprises. Especially found in overgrazed pastures where there is little competition. Sharp spines on fruits hamper stock handling. Poisoning can occur in young sheep grazing on it.	Neg	Neg-Low	Impact on enterprises unlikely to change. Has probably reached all suitable habitats and further expansion in distribution unlikely under current climate.	No	Yes
Ulex europaeus	Gorse	S	Mod	Mainly a weed of unimproved grazing land in high rainfall areas of temperate regions (primarily Tas and Vic). Unpalatable to cattle. Mature growth eaten by goats, but only new growth is palatable to sheep. Blocks access and prevents movements of stock. Control is costly because a combination of different methods is required and follow-up is necessary. Biocontrol agents released so far have not proved to be effective in managing populations.	Mod	Low-High	Has probably reached its potential range. Infilling could lead to problems for currently un-infested enterprises.	Yes	Yes

Taxa	**Common name**	**Climate zone**	**Current impact** (Negligible, low, moderate, high)	**Current impact rationale** (add comment to provide justification for impact category chosen)	**Potential impact** (Negligible, low, moderate, high)	**Potential impact range** (to capture uncertainty)	**Potential impact rationale** (include key assumptions)	**Inclusion in biocontrol assessment** (yes, combined or no; no is selected when weed has Negligible current and potential impact)	**Currently or previously targeted by a biocontrol research in Australia and/or elsewhere** (yes/no)
Vachellia nilotica ssp. *indica* (syn. *Acacia nilotica* ssp. *indica)*	Prickly acacia	N	High	Heavy infestations result in pasture loss, and also affect mustering and can result in erosion. Control is expensive once widely established. There are already enterprise-level impacts across large parts of the Mitchell grasslands in QLD, including on well-managed properties.	High	High	The problem is expected to continue to worsen in the absence of new control options. This includes black soil plains and other habitats across the northern savannas.	Yes	Yes
Vulpia spp.	Vulpia or silvergrass	S	Low	Exotic annual grass that competes with more desirable pastures in temperate areas and produces lower quality feed. It has however, some grazing value at times of the year and therefore cannot be considered as causing serious enterprise-level production losses. Management strategies involving tactical grazing and fertiliser use can significantly reduce the vulpia content of pastures, which can be maintained with good grazing management.	Low	Low-Mod	Already very widespread. Infestations could potentially increase in density in marginal grazing land.	Yes	Yes
Xanthium occidentale (syn *X. strumarium*)	Noogoora burr	W	Low	Used to be a major problem in south-east QLD, but since the introduction of a rust fungus populations have drastically declined and it is now a minor weed. It is still found along river systems in NSW, NT and northern WA, but doesn't specifically affect livestock enterprises. Seedlings poisonous to livestock. Burrs contaminate wool and can reduce value.	Low	Neg-Low	Has potential to become more of a problem for grazing properties along the Murrumbidgee river, where climate is not conducive to severe epidemics by the rust biocontrol agent, which has been highly effective in controlling the weed in south-east QLD.	Yes	Yes
Xanthium spinosum	Bathurst burr	W	Low	Widespread, but generally localised within enterprises to high fertility disturbed areas i.e. associated with sheep camps and wet areas (watercourses, dam banks, flood plain). Seedlings are poisonous to livestock but it is not a major problem in Australia. It is one of the causes of vegetable faults in Australian wool.	Low	Low-Mod	Already widespread. Infestations could potentially increase in density in marginal grazing land.	Yes	Yes
Ziziphus mauritiana	Chinee apple	N	Low	Beginning to form dense infestations on significant parts of properties in the Charters Towers to Townsville area of QLD with loss of pasture, difficulties in riparian access and mustering. Dense along riparian strips but also uplands particularly in wetter areas. Has particularly slow rate of increase, but once established doesn't go away and is very difficult to manage. Can become dense even under relatively good management.	Mod	Mod-High	Infestations continue to increase in size and density, albeit very slowly due to slow population growth rates. It is has the potential to become dominant over large well-managed areas, at least initially in Charter Towers/Townsville region of QLD where it is already widely established. There are no cost-effective management options on the horizon beyond managing large trees which contribute most seed. However, management is aided by slow growth rates.	Yes	No

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Reduce fuel load to avoid high to catastrophic fire that affect properties across savannas. Reduce loss of livestock carrying capacity as a result of pastures being replaced by high biomass gamba that remains "rank" for long periods. Slow spread (including in QLD).	*Low*	*Potential resistance to BC still needs to be assessed and if possible resolved. No known host specialists, although specific searches have not been made. Feasibility would increase once approved as a target for BC, and subject to results from preliminary native-range work.*	*Low*	*Ranked as low on the basis that grasses have historically been difficult targets, and on the lack of knowledge about the plant and its natural enemies in its native range. However, its' ecology, and early success on a structually similar high biomass grass (Arundo donax) suggests it may nonetheless be promising target.*	*Low*	*Several barriers to successful biocontrol, but good reasons to suggest that these could be addressed and overcome within a reasonable time span.*	*1. Obtain support as target for biocontrol, including conducting necessary stakeholder consultation. 2. Preliminary surveys to determine extent of native range (including of relevant "sub species") and their natural enemies.*	*n/a*
Improve livestock carrying livestock capacity by reducing population density and competitive ability. Reduce prevalence of the most important pasture pest of southern Australia, red legged earth mite, which uses the weed for shelter.	*Low*	*A desirable pasture plant for farmers in WA, so likelihood of undertaking biocontrol limited because of expected opposition. Good potential agents known, likely to be host-specific. However, to overcome possible conflict with those who value it, agent(s) will need to be specific toward the putatively different weedy form found in eastern Australia.*	*Mod*	*Unlikely that damage will occur early enough in the growing season to prevent seeding. Damage that reduces competitive ability would be required every year since it is annual species with long-lived seed.*	*Low-Mod*	*The main initial barrier to biocontrol is the possible conflict between those who value the plant in WA and others who consider it weedy in the eastern states.*	*1. Perform a genetic study to determine if there are differences between the putative eastern and western forms of the weed to decide if biocontrol is a viable option considering potential conflict between eastern and western graziers.*	*n/a*
Improve livestock carrying livestock capacity by reducing population density and competitive ability.	*Mod*	*Nomination as a target for biocontrol will remain a challenge until more data on its impact are gathered. Good prospect to find a host-specific rust strain since it did not infect a congener species in preliminary testing. No other known potential agents, although comprehensive surveys have not been performed.*	*Mod*	*Rust fungus may cause sufficient damage on plants in the field to sufficiently reduce competitiveness, but may not be effective across all climatic conditions where the weed occurs.*	*Mod*	*The main barrier to the initiation of a biocontrol program is the current lack of data on impact of the weed to support a nomination as a biocontrol target. There is good prospect of finding a host-specific rust strain that would cause sufficient damage on the weed across part of its*	*1. Determine if there are sufficient data to support nomination as a biocontrol target; if so nominate. 2. Test rust strains on Australian accessions of the weed to determine if there are any genotype matching issues. 3. Conduct preliminary tests on a few key native species in the Xanthorrhoeaceae family before embarking on a comprehensive host-specificity testing program.*	*n/a*
Improve farm management by not having to consider risk of poisoning of naïve livestock when moving them within and between properties.	*Low*	*Two weevils impact important nursery species and their release is therefore dependent on a Benefit-Cost Analysis and use of the Biological Control Act. Unlikely to find further host-specific agents.*	*Mod*	*Stem-borers are expected to be able to cause the required damage, provided they reach sufficient densities across the at-risk area.*	*Low-Mod*	*Potential agents are limited to 2 stem-boring weevils. The Biocontrol Act will need to be used to gain approval for release because of host range issues.*	*1. Follow the two tested beetle species through the Biocontrol Act. This would require quantification of actual and potential impact of the target (and non-targets). 2. Critically assess past exploration/testing work to determine whether other options are available.*	*No actions identified.*

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Make it less competitive so that it doesn't become dominant, or persist, even under moderately high levels of disturbance (such as around water points).	*Mod*	*Based on existing known agents, and the avenues for finding more, although native-range still needs to be properly delimited (through taxonomic work) and may include inaccessible regions.*	*Mod*	*No reason to believe that it will be a particularly difficult target provided more potential agents can be found. Low likelihood if only multi-voltine seed/fruit feeders are available as they have a poor track record on their own for perennials. The climatic diversity of the target region (northern Australia) may necessitate multiple agents.*	*Mod*	*Likely to be find host-specific agents. Goals for biocontrol are relatively achievable provided the right types of agents can be found.*	*1. Better understand potential impact of the weed, including relationship to grazing management regimes, and longevity of existing infestations. 2. Assess existing potential agents against likelihood of impact, prior to host-range testing. 3. Conduct native-range surveys, once it has been established.*	*n/a*
Improve livestock production on farm by increasing access to more pasture by reducing weed patch size, population density and biomass. Reduce the need of and/or frequency of other weed management tactics by lowering recruitment of the weed. Reduce the spread of the weed by reducing seed availability (propagule pressure).	*Low*	*No new agents expected to be found in the native range that could enhance existing biocontrol.*	*Low*	*Biocontrol program established many years ago and indications are that it is having a major impact.*	*Low*	*Biocontrol program established many years ago and having a major impact. No new agents expected to be found in the native range that could enhance existing biocontrol.*	*No actions identified.*	*Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.*
Improve livestock production on farm by increasing access to more pasture by reducing weed patch size, population density and biomass. Reduce the need of and/or frequency of other weed management tactics by lowering recruitment of the weed. Reduce the spread of the weed by reducing seed availability (propagule pressure).	*Low*	*Candidate insect agents have been identified but all are already known to attack other Cardueae (artichoke and native species) and thus there are no options unless more specific insect biotypes are found.*	*High*	*Based on success observed with C. nutans, rosette-feeding insect agents could potentially have a high impact on growth and competitiveness of the weed, especially if combined with pasture competition.*	*Mod*	*While crown-feeding rosette agents have been successful for other thistle species, there are no options to enhance biocontrol of this species because of lack of additional specific agents.*	*1. Perform gap analysis of previous surveys data to better assess chances of finding a host-specific rosette-feeding insect agent.*	*Rust fungus has likely naturally spread to all suitable sites and redistribution is not necessary. Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.*
Improve livestock production on farm by increasing access to more pasture by reducing weed patch size, population density and biomass. Reduce the need of and/or frequency of other weed management tactics by lowering recruitment of the weed. Reduce the spread of the weed by reducing seed availability (propagule pressure).	*Low*	*Comprehensive surveying across native range completed, and only one candidate agent, the rosette crown-feeding fly, found to be sufficiently specific (i.e. no attack on safflower). Limited prospect to find other agents that do not affect safflower.*	*Mod*	*Plants can easily compensate for damage, so level of attack on rosettes would need to be high. Uncertainty about the ability of rosette crown-feeding fly to cause sufficient damage to reduce populations of the weed.*	*Low-Mod*	*Only one possible agent available for biocontrol considering the likely conflict that would occur should agents that affect safflower are proposed for release.*	*1. Investigate impact of the rosette crown-feeding fly in a plant competition experiment to better assess its potential for biocontrol. 2. If point 1 is promising, then nominate the weed as a biocontrol target. 3. Undertake comprehensive host-specificity testing with the fly.*	*Consider developing a non-commercial augmentative biocontrol approach to enhance the efficacy of the existing Phomopsis spp. pathogens that affect the weed, since the market potential for a commercial bioherbicide is too low to justify costs of development.*
n/a	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*
Future grazing management in northern savannas not dictated by weed (through reduced competitiveness)	*Low*	*Limited knowledge, low expectation of potential agents that are sufficiently host specific.*	*Low*	*Nothing to suggest that it will be an easier target then other grasses*	*Low*	*Expected to be a challenging target with high host-specificity requirements.*	*1. Nominate as target. 2. Confirm taxonomy/origin. 3. Conduct preliminary native range surveying, perhaps piggy-backed on to other work.*	*n/a*

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Slowing spread to allow time for "transition to management", reducing its ability to become dominant in pasture systems across northern Australia.	*High*	*At least several host-specific agents known through biocontrol programmes conducted by other countries.*	*High*	*Effective biocontrol in other countries on the same genotype and in similar environments suggests it will also be effective in Australia.*	*High*	*A range of well-studied agents available from overseas, including species that have been effective on the same genotype and under similar conditions.*	*1. Determine and progress with the most promising agents from overseas (work is already underway).*	*n/a*
Improve livestock production on farm by increasing access to more pasture by reducing weed patch size, population density and biomass. Reduce the need of and/or frequency of other weed management tactics by lowering recruitment of the weed. Reduce the spread of the weed by reducing seed availability (propagule pressure).	*High*	*Of the extensive number of natural enemies found on this weed in the native range, there are chances that additional agents sufficiently host-specific for the Australian situation could be found, especially considering precedents with Carduus and Onopordum spp. Pathogen survey currently being undertaken may reveal promising candidate, although note that the rust fungus that attacks this weed is already present in Australia.*	*Low*	*Considering the extensive work done on the biocontrol of this weed and the poor track record of agents released/established in other countries for this weed, which included a stem miner (although no crown/root feeder were ever released), it is legitimate to conclude that it is a difficult target and chances of achieving successful biocontrol are low.*	*Mod*	*Good prospect to find additional host-specific biocontrol agents considering that Australia does not have native Cirsium spp. However, precedents in other countries indicate that very high levels of damage would be required to control the weed.*	*1. Wait for results from New Zealand on impact of new agents released or to be released.* *2. If point 1 is promising, conduct preliminary host-specificity tests to confirm that they do not attack Australian native species in the tribe Cardueae before any further assessment.*	*Wait for results from New Zealand on options to enhance the efficacy of the rust fungus Puccinia punctiformis on this weed using an augmentative biocontrol approach. If promising, conduct trials in Australia.*
Improve livestock production on farm by increasing access to more pasture by reducing weed patch size, population density and biomass. Reduce the need of and/or frequency of other weed management tactics by lowering recruitment of the weed. Reduce the spread of the weed by reducing seed availability (propagule pressure).	*Mod*	*Of the extensive number of natural enemies found on this weed in the native range, there are chances that additional agents sufficiently host-specific for the Australian situation could be found, especially considering precedents with Carduus and Onopordum spp.*	*High*	*Still missing a key agent in the suite released that would attack the crown/root of the weed (seed feeders will not do the job alone). Based on success observed with other thistles, rosette-feeding insect agents could potentially have a high impact on growth and competitiveness of the weed, especially if combined with pasture competition.*	*Mod-High*	*Good prospect to find additional host-specific biocontrol agents considering that Australia does not have native Cirsium spp. Finding a damaging crown-root weevil would complement existing agents and increase likelihood of achieving successful biocontrol.*	*1. Investigate the genetics of the weed to identify most appropriate areas of native range to survey to find a crown-root weevil that attack the form of C. vulgare presents in Australia.*	*Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.*
Reduce pasture loss by making existing infestations in high-value habitats smaller and less dense, especially in areas where the existing rust pathogen doesn't perform so well (northern and drier areas). Prevent future impacts by reducing its ability to become dense in new areas.	*Low*	*Already comprehensively surveyed. Wouldn't expect to find additional host-specific agents.*	*Low*	*Low based on impacts of existing agents, and lack of further host-specific agents. Assessment might change if further potential agents are discovered, and what they were.*	*Low*	*Unlikely to find further host-specific agents.*	*1. Critically assess past exploration/testing work to determine whether other options are available.*	*Evaluate/quantify the distribution and effectiveness of the two existing agents (a rust and a moth), to determine whether their impact can be increased through redistribution, e.g., around Rockhampton and in the Kimberley. Identify whether there is a need for new biocontrol agents.*
Prevent it from forming extensive, dense infestations that will cause lost production and seriously impact property management. Make it affordable to manage using existing chemical and mechanical control tools. Slow the spread to other areas by reducing seed outputs.	*Low*	*Comprehensive surveying for natural enemies across native range completed and all available suitable agents have been released in Australia. New Zealand introduced two additional insect agents, but it is unlikely that they would ever get approval for release in Australia because they can attack tagasaste, a valuable fodder crop used in WA.*	*Low*	*Some prospect to enhance biocontrol by introducing additional agents, although the long-lived seedbank and rapid recruitment following stand density reduction, strongly indicate that an integrated weed management approach may be more successful at achieving goals.*	*Low*	*Prospect to introduce additional agents is limited because of lack of specificity. Integration of current biocontrol agents with other control methods that specifically target recruitment from the large and long-lasting seedbank following death of adult plants may be a more appropriate approach.*	*No actions identified.*	*Distribute Aceria mite agent, which is very slow to spread naturally, into non-contiguous areas where it is not present. Evaluate/quantify the impact of agents released (including the rust that was not an authorised release), assess if impact can be enhanced through IWM and develop recommendations for farmers.*

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n/a	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*
Improve livestock carrying capacity by reducing population density and competitive ability.	*Low*	*No new agents expected to be found in the native range that could enhance existing biocontrol.*	*Low*	*Biocontrol program established many years ago and indications is that it is having a major impact.*	*Low*	*Biocontrol program established many years ago and having a major impact. No new agents expected to be found in the native range that could enhance existing biocontrol.*	*No actions identified.*	*Assess existing data on impact of released agents and collect additional data if necessary. Assess if impact can be enhanced through IWM and/or further redistribution of agents and develop recommendations for farmers. Revisit initial economic analysis*
Improve livestock carrying capacity by reducing population density and competitive ability.	*Low*	*Comprehensive surveying of arthropods across native range completed and most options have been investigated. There remains two candidate agents. The weevil Perapion neofallax is promising because of its ability to diapause over summer when the weed is not growing in Australia, but major difficulties in rearing it have been encountered in the past. A Cercospora leaf pathogen could also be considered for use in biocontrol.*	*Low*	*Weed is able to tolerate extensive damage and still produce seed. It is already being attacked by two natural enemies across its range without providing control. Additional candidate agents have attributes (diapause, spores) that might favour establishment, although their potential impact on the weed is unknown.*	*Low*	*Biocontrol program established years ago without any agent becoming established. Potential agents remain to be investigated, but will need to take into account weeds annual lifecycle and dry hot conditions or region infested.*	*1. Recollect the weevil P. neofallax in Tunisia and develop appropriate rearing techniques so that preliminary testing on native Rumex spp. can be undertaken to assess its potential for biocontrol.* *2. Assess Cercospora spp. from Africa.*	*No actions identified.*
Grazing management is not dictated by weed (through reduced competitiveness), thus improving farm management operations.	*Unfeasible*	*Unfeasible biocontrol target as species can be both problematic and useful as a pasture, depending on setting and cultivar.*	*n/a*	*n/a*	*Unfeasible*	*An unfeasible biocontrol target as species can be both problematic and useful as a pasture, depending on setting and cultivar.*	*No actions identified.*	*n/a*

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n/a	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*
Improve livestock carrying capacity by reducing population density and competitive ability.	*Mod*	*Limited knowledge of natural enemies in native range as no surveys have been performed. There are records of the rust Melampsora euphorbiae infecting this weed in the native range. Good prospect to find a rust strain that would not pose a threat to Australian native Euphorbia spp.*	*Mod*	*High level of defoliation would be required since the plant is a long-lived perennial with a basal crown.*	*Mod*	*Good prospect to find a rust strain that would not pose a threat to Australian native Euphorbia spp. High level of defoliation would be required since the plant is a long-lived perennial with a basal crown.*	*1. Determine if there are sufficient data to support nomination as a biocontrol target; if so nominate. 2. Perform an initial survey, especially to find the rust pathogen so that testing on Australian accessions of the weed can be performed to determine if there are any genotype matching issues. 3. Perform preliminary testing on key native Euphorbia spp. to obtain an indication of host-specificity before embarking on a comprehensive host-specificity testing program.*	*n/a*
n/a	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*
Prevent it from emerging as a serious problem (to livestock carrying capacity and farm management) in southern QLD.	*Low*	*Further agents not expected to be found.*	*Low*	*Low in the absence of knowledge about further agents.*	*Low*	*Comprehensively surveyed. No further host-specific agents expected to be found.*	*1. Critically assess past exploration/testing work to determine whether other options are available.*	*Determine reason why biocontrol is apparently not as effective in southern Qld and northern NSW. Then identify whether the problem can be overcome, e.g., through additional releases*
Reduce the need and/or frequency of other weed management tactics by reducing seed production.	*Unfeasible*	*Desirable fodder at some times of the year. Closely-related to barley crop and therefore it would never be endorsed as a candidate for classical biocontrol.*	*n/a*	*n/a*	*Unfeasible*	*Unsuitable target for classical biocontrol. Desirable fodder at some times of the year and closely-related to barley, a major crop.*	*No actions identified.*	*n/a*

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Prevent it from emerging as a serious problem (to livestock carrying capacity and farm management) in southern QLD.	*Low*	*A poorly studied, unsurveyed, grass species that is expected to have a relatively depauperate fauna.*	*Low*	*A poorly studied grass species that is expected to be relatively resilient to herbivory and damage.*	*Low*	*Poorly studied species with native congeners. It is expected, in the absence of further information, to be a difficult target.*	*1. Determine native-range and conduct preliminary surveys of natural enemies.*	*n/a*
Grazing management is not dictated by weed (through reduced competitiveness), thus improving farm management operations.	*Low*	*Comprehensive surveying of arthropods across native range completed and all options have been investigated. There may be potential specific pathogen agents in the native range that have been overlooked during arthropod surveys. Candidate pathogen agents would need to infect all forms of the weed present in Australia.*	*Low*	*A difficult target considering that it is still a problem in parts of its range despite the large number of agents that have been released. Asynchrony between agents and the weed and/or sub-optimal climatic conditions for agent development may be important factors. Low prospect to find highly damaging and widespread pathogens in the native range, because one would expect that they would have been noticed during the extensive surveys performed over the years.*	*Low*	*Low prospects to find additional agents with good potential to enhance biocontrol of this weed across its range.*	*1. Consider performing an additional survey in the native range specifically targeting potential pathogen agents.*	*Determine why the beetle Agrilus hyperici has so poorly established in Australia, and, if resolved, rear and distribute this agent in areas where other agents do not perform as well. Evaluate/quantify the impact of all agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers. Investigate the genetics of the weed to identify most appropriate areas of native range to collect more efficient strain(s) of the mite Aculus hyperici. It is most likely that there is a mis-match between the main form of the weed in Australia and the strain of the mite released because damage in Australia is far less severe than in the native range.*
n/a	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*
n/a	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*

Primary goal(s) of biocontrol program based on current situation	Feasibility of undertaking biocontrol program (unfeasible, low, Moderate, high) (see guidelines) If unfeasible do not progress further	Feasibility rationale	Likelihood of success of biocontrol program (low, Moderate, high) (see guidelines)	Likelihood rationale	Biocontrol prospects to mitigate impact (low, Moderate, high) (see guidelines)	Biocontrol prospects explanation	New agents–Key investment area(s) (Possible actions to change rankings of biocontrol feasibility and/or likelihood of success)	Existing natural enemies/released agents–Potential investment area(s) (Possible actions to enhance impact of existing agents)
Avoid future impacts (to livestock carrying capacity) across the savannas by preventing formation of extensive monocultures, or allowing that to be achieved by making other management options cost-effective and achievable	*Low*	*Host-testing of rust still to be completed. Otherwise, there are no known potential agents despite comprehensive surveying. Long shot opportunities on congeners and likely introduced range of this weed in South America.*	*Mod*	*Rusts have a track record of being highly effective, although it will have to perform well across diverse climates and genotypes. Likelihood becomes low in the absence of knowledge about further agents.*	*Low-Mod*	*Rust offers best opportunity, although it may not be sufficiently host-specific. Further potential agents unlikely, and it remains a moderately challenging biocontrol target.*	*1. Complete host-specificity testing of rust, and release if safe.* *2. Targeted exploration of congeners outside of the weed native range in South America.*	*Consider re-releasing the jewel bug with a broader genetic base to improve impact. The initial introduction was based on one importation that was bred in the laboratory for several years prior to release. Explore whether natural dieback phenomenon can be exploited.*
Improve production by reducing cover of existing infestations and making lantana less likely to become dense. Priority areas are along and east of the Great Dividing Range (e.g. around Townsville, south-east QLD and northern NSW), including in open woodlands, riparian zones and open grasslands.	*High*	*Additional host-specific agents already being studied in South Africa. Further potential agents could potentially be found through targeted searching based on modern taxonomy and an analysis of past survey effort.*	*Low*	*Precedence (in Australia and elsewhere) suggests that lantana is a very challenging target, and that the types of agents that are most likely to regulate populations are few.*	*Mod*	*Further host-specific agents are likely to be found, but lantana in Australia will likely remain a challenging biocontrol target.*	*1. Conduct comprehensive gap analysis of historical native-range surveying in the light of recent genetic studies, and evaluate the potential for locating potentially damaging agents.* *2. Consider further survey work, based on the gap analysis, specifically focussed on potential agents that are most likely to result in biocontrol goals being met.*	*Could potentially revisit the c 13 species that failed to establish. However, their potential to cause the required impact would need to be assessed and host-specificity confirmed for some species. Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.*
Reduce potential impacts by making it less likely to become dense.	*High*	*Relatively poorly surveyed, but would expect to find a diverse fauna, including potentially host-specific species.*	*Low*	*Low based on precedence from Lantana camara, but this species does not have hybrid problems that L. camara has. Very high degree of uncertainty due to lack of knowledge. However, agents would need to be able to cope with long drought conditions.*	*Mod*	*A poorly understood species. No apparent barriers to finding host-specific agents, but experiences from L. camara suggest that it could be a challenging target.*	*1. Need to know a lot more about the target before commencing a serious biocontrol effort.*	*Could revisit past efforts. Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.*
Prevent it from forming extensive, dense infestations that will cause lost production and seriously impact property management. Make it affordable to manage using existing chemical and mechanical control tools. Slow the spread to other areas by reducing seed outputs.	*Mod*	*Limited knowledge of natural enemies in native range as no surveys have been performed, although fauna expected to be large. There are records of the rust Puccinia rapipes infecting the weed in the native range. Good prospect to find a rust strain that would not pose a threat to the Australian native Lycium australe. It is unknown if Insect natural enemies would have the required specificity.*	*Mod*	*A hardy target, but reasons to believe that agents could be found that will help meet biocontrol goals. Would require extensive defoliation over several years to reduce density and biomass of infestations.*	*Mod*	*Hardy target that would require extensive defoliation over several years to reduce density and biomass of infestations. Good prospect of finding host-specific agents (e.g. rust) that will be damaging.*	*1. Nominate as a biocontrol target.* *2. Perform an initial survey, especially to find the rust pathogen so that testing on Australian accessions of the weed can be performed to determine if there are any genotype matching issues.* *3. Perform preliminary tests on the native Lycium australe to obtain a key indication of host-specificity before embarking on a comprehensive host-specificity testing program.*	*n/a*

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Improve livestock carrying capacity by reducing population density and competitive ability.	*High*	*Comprehensive surveying for arthropod natural enemies across native range completed. Three insect species (Cerambycid, Nitidulid and Butterfly) with potential for biocontrol have already been identified and have good chances of being host-specific (considering there are no closely-related native and economic species to M. vulgare in Australia), but difficulties were encountered in the past to establish colonies of these species. There may be potential pathogen agents in the native range that have been overlooked during arthropod surveys, although highly damaging and widespread pathogens on the weed would more than likely have been noticed during these surveys if present.*	*Mod*	*Field observations made on the first two agents released, indicate that the weed is sensitive to herbivory and can be severely impacted on if climatic conditions are suitable. Prospect to enhance biocontrol efficacy with new agents are promising, especially if they are active in areas where current agents are not.*	*Mod-High*	*Good prospect that already identified potential insect agents will be host-specific. Difficult to predict though that they will be damaging in areas where existing agents are not performing well.*	*1. Recollect and attempt again to establish colonies of the three potential agents identified during surveys so that host-specificity tests can be performed.* *2. If insect agents proved too difficult to rear, consider undertaking additional surveys specifically for pathogens.*	*Distribute clearwing moth agent, which is very slow to spread naturally, into non-contiguous areas where it is not present. Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.*
n/a	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*
Improve livestock carrying capacity in invaded wetlands by reducing cover, and reduce control costs.	*Low*	*Comprehensively surveyed across native-range. Further potential agents not expected.*	*Low*	*It is a relatively tough biocontrol target and environment. Low in the absence of knowledge about further potential agents.*	*Low*	*It is a relatively challenging biocontrol target. Furthermore, additional host-specific agents are unlikely to be found.*	*No actions identified.*	*Continue redistributing Nesaecrepida infuscata which is now established. Assess the large amounts of unpublished, semi-analysed post-release data to determine whether impacts of existing agents could be enhanced. Non-classical biocontrol: explore whether natural dieback phenomenon can be exploited. Determine whether there is any value in reintroducing agents that failed to either establish or thrive. Explore whether natural dieback phenomenon can be exploited.*
Improve livestock carrying capacity by reducing population density and competitive ability.	*Mod*	*Rust fungus identified in previous surveys as most promising biocontrol agent. However, because of the extreme specificity of the rust, several strains may be required to attack all putative genotypes of Cape tulips present in Australia.*	*Mod*	*Rust fungus is the most likely organism to be developed for biocontrol - severe infections have been seen in some instances in South Africa. Conditions during winter when plants grow are conducive to development of rust epidemics. High defoliation of plants is required to prevent reshooting from corms, although lower levels may be adequate when pasture competition is considered.*	*Mod-High*	*Prospect of biocontrol with the rust fungus is promising. However, more than one strains of the rust are likely to be required to attack the range of genotypes found in Australia.*	*1. Finalise identification of Australian genotypes and use these to source virulent rust strains for subsequent host-specificity testing.*	*n/a*

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Grazing management is not dictated by weed (through reduced competitiveness), thus improving farm management operations. Slow the spread to other areas by reducing seed outputs.	*Mod*	*All possible candidate pathogen agents have probably be found considering the surveying efforts, albeit not across the entire range, over many years. There are still opportunities to identify host-specific strains in the two rust fungi that have not been fully investigated.*	*Low*	*Grass expected to be resilient to defoliation by natural enemies. Severe infection by one or more pathogen agents over several years would be required to reduce density and biomass of infestations and seed outputs.*	*Low-Mod*	*There is some prospect that host-specific and damaging strains of the two candidate rust fungi, which have not been thoroughly investigated, could be found.*	*1. Consider comments received on application for release of Uromyces pencanus in Australia and undertake additional tests if necessary to support risk analysis (could wait to see how the rust establishes and spreads in New Zealand, where it has been approved for release, before investing in additional tests).* *2. Re-assess previous research and decide if additional efforts are warranted to further explore Puccinia nassellae and Puccinia graminella for Chilean needle grass biocontrol in Australia.*	*n/a*
Grazing management is not dictated by weed (through reduced competitiveness), thus improving farm management operations. Slow the spread to other areas by reducing seed outputs.	*Low*	*Prospects of finding additional candidate pathogen agents that are host-specific are limited, considering that the areas where the weed is most common in Argentina have been surveyed several times over many years.*	*Low*	*Grass expected to be resilient to defoliation by natural enemies. Severe infection by one or more pathogen agents over several years would be required to reduce density and biomass of infestations and seed outputs.*	*Low*	*Considering past efforts, there is a low prospect that host-specific and highly damaging strains of the candidate pathogen agents identified could be found.*	*No actions identified considering the major efforts of the last 10 years to find a classical biocontrol solution for this target.*	*Investigate soil pathogens suspected to regulate serrated tussock populations in Australia. These may be amenable to an augmentative biocontrol approach.*
Improve livestock production on farm by increasing access to more pasture by reducing weed patch size, population density and biomass. Reduce the need of and/or frequency of other weed management tactics by lowering recruitment of the weed. Reduce the spread of the weed by reducing seed availability (propagule pressure).	*Low*	*No new agents expected to be found in the native range that could enhance existing biocontrol.*	*Low*	*Biocontrol program established many years ago and believed to be having an impact on stemmed Onopordum spp. but never quantified.*	*Low*	*Biocontrol program established many years ago and believed to be having an impact but never quantified. No new agents expected to be found in the native range that could enhance existing biocontrol.*	*No actions identified.*	*Determine compatibility of released strains of the crown weevil Trichosirocalus briesei towards stemless Onopordum (O. acaulon) in SA and WA, and if compatible redistribute on this species. Evaluate/quantify the impact of agents released (including those on O. acaulon), assess if impact can be enhanced through IWM and develop recommendations for farmers.*
Prevent it from forming extensive, dense infestations that will cause lost production and seriously impact property management. Make it affordable to manage using existing chemical and mechanical control tools. Reduce and maintain it at the same level as prickly pear.	*High*	*Further host-specific agents are expected to be relatively easily found for most target species, once their taxonomy has been clarified.*	*Mod*	*Good precedent for effective control, including against some species that have already been targeted in Australia. Great opportunities presented by new knowledge on potential agents. However, breadth of target species and geographic regions do pose challenges.*	*Mod-High*	*The main barrier to successful biocontrol is the range of species and geographic regions to be targeted. Nonetheless, there are considerable synergies possible from addressing them simultaneously.*	*1. Clarify the taxonomy of naturalised species in Australia, and prioritise them for biocontrol.* *2. Synthesis and gap-analysis of past work, including identifying biocontrol taxa already present in Australia.* *3. Consider assessing the identified races of Cactoblastis and Dactylopius (cochineal insects) against the Australian invasive taxa (in a matrix design) to identify those that will have greatest impact on the highest priority Opuntioid species.*	*Using genetic analyses determine what Dactylopius species we have in Australia, and their preferred hosts. Any re-releases may require retesting as these species were unintentionally left off the Federal Approved Release List for Biocontrol agents. Evaluate/quantify the impact of selected agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.*

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Same as for the group above	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*
Same as for the group above	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*
Same as for the group above	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*
Same as for the group above	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*
Same as for the group above	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*
Same as for the group above	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*
Same as for the group above	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*
Mustering not hampered by weed and reduce cost of control. The highest priority is central QLD to the Gulf of Carpentaria and Barkly Tablelands.	*Low*	*Comprehensive surveying across native range completed, and finding further potential agents is considered unlikely after the release of the two existing Geometrid species.*	*Low*	*Lack of apparently damaging agents in the native range. Challenging ecology for a target, especially given lack of apparently damaging agents in the native range, although there is potential for synergies with "dieback", and management goals are not onerous.*	*Low*	*A reasonably difficult target with few prospects of finding further host-specific, damaging agents (following release of the 2 geometrid agents).*	*1. Additional surveying in the few remaining areas identified by native-range survey analysis that are most likely to yield additional agents. This includes resolving the taxonomy in South American native range (esp Argentina) to guide searches.*	*Follow through on national release and redistribution of two existing agents (one approved, the other subject to approval). No further benefits are expected from previously released agents. Non-classical biocontrol: explore whether natural dieback phenomenon can be exploited.*

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Grazing management in affected areas not dictated by weed (through reduced competitiveness), especially in at risk areas such as southern QLD and northern NSW. Reduce potential human-health effects (caused by pollen) that are expected to result from increased densities in high population areas such as southeast QLD.	*Low*	*No real opportunities identified for finding more potential agents.*	*Low*	*Low based on absence of potential agents. Precedence suggests that effective biocontrol is possible, although it remains a relatively difficult target.*	*Low*	*Further potential agents are considered unlikely. Furthermore, it remains a relatively difficult target.*	*No actions identified.*	*Assess the distribution of the most effective agents and, if required, distribute them into non-contiguous places (southern Qld). Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.*
Increased livestock carrying livestock capacity in wetlands through decrease in cover. Grazing management is not dictated by the weed (through reduced competitiveness), thus improving farm management operations, including reliance on cultivation as a management tool.	*Low*	*Few prospects for finding host-specific agents.*	*Low*	*Expected to be a challenging biocontrol target that spreads both clonally and by seed. Only one potentially damaging natural enemy known, and it hasn't been relocated.*	*Low*	*Hardy plant that spreads both clonally and by seed, with few prospects of finding agents capable of causing the required damage to survival and reproduction.*	*1. Locate rust on P. reptans and determine its relative preference for P. canescens. This is likely to require dedicated resources and development of contacts in Bolivia. Rusts have good track records as biocontrol agents.*	*n/a*
Improve livestock carrying capacity by reducing population density and competitive ability.	*Low*	*No known host specialists, although specific searches in the native range have not been made. Feasibility may increase once results from preliminary surveys in native range are obtained.*	*Mod*	*Severe and continuous defoliation on the related weed Solanum elaeagnifolium in South Africa has been shown to have a major impact, even though it has an extensive root system like P. viscosa. On this basis, it may be possible to find sufficiently damaging agents.*	*Low-Mod*	*A challenging biocontrol target because of its closeness to Cape gooseberry and native Physalis spp. Prospect may increase once knowledge of natural enemies is obtained.*	*1. Determine if there are sufficient data to support nomination as a biocontrol target; if so nominate. 2. Perform genetic study to identify more precisely region of origin of Australian populations. 3. Perform an initial survey of insect and fungi natural enemies there.*	*n/a*
Avoid future impacts (to livestock carrying capacity and property management) by preventing formation of extensive monocultures, or allowing that to be achieved by making other management options cost-effective and achievable.	*High*	*Expect to find diverse range of sufficiently host-specific, culturable organisms relatively easily.*	*Mod*	*A hardy host, but reasons to believe that additional agents could be found that will help meet biocontrol goals.*	*Mod-High*	*A hardy host, but reasons to believe that sufficiently host-specific and damaging agents could be found and studied relatively easily.*	*1. Confirm high feasibility through a gap analysis of previous work and more comprehensive survey. 2. Host testing of potential agents following careful prioritisation based on potential impact, including evaluation of South African work.*	*No actions identified.*

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Improve livestock carrying capacity by reducing population density and competitive ability.	*Low*	*Even if additional areas in native range are surveyed, there is limited prospect of finding host-specific agents as the weed is very closely-related to edible radish. Pathogen agents may be the only option for host-specificity.*	*Low*	*Weed known for its ability to compensate when damaged and thus would require highly damaging agents.*	*Low*	*Low prospect of finding host-specific agents that are highly damaging. Very closely related to edible radish.*	*No actions identified.*	*Consider developing a non-commercial augmentative biocontrol approach to enhance the efficacy of existing pathogens that affect the weed in Australia, especially Hyaloperonospora parasitica, which is genetically distinct to isolates found on Brassica spp. including canola.*
Improve livestock carrying capacity by reducing population density and competitive ability.	*Low*	*Considering previous work, there are few options remaining to identify host-specific agents among the limited number of natural enemies.*	*Low*	*Of all identified natural enemies, only seed-feeders remain as a possibility. They are however, unlikely to provide the necessary control to achieve the goal of biocontrol.*	*Low*	*Low prospect of finding host-specific agents that are damaging to the roots, stems and/or foliage of the weed.*	*No actions identified, beside establishing if it is a weed that is of real concern to grazing industries. It is mainly a weed of cropping and may only be relevant to grazing within the context of grazing-crop rotation.*	*n/a*
Improve livestock carrying capacity by reducing population density and competitive ability. Reduce the need and/or frequency of other weed management tactics by reducing seed production.	*Low*	*Natural enemies mostly unknown as the weed has not been surveyed in the native range, but fauna expect to be limited. However, good prospect of finding a host-specific agent since there is no Australian native species in the same genus. A rust fungus is recorded on it in the native range, although it is also known to infect three other species in the Iridaceae, so a pathotype specific to Romulea spp. would have to be found.*	*Mod*	*Known to be sensitive to defoliation (it has few leaves), so pending a damaging agent is found that can oversummer when the weed is dormant, biocontrol has good chances of being successful.*	*Low-Mod*	*Although has not been surveyed before, there is some prospect of finding host-specific agent(s) that will be impactful since the weed is sensitive to defoliation (because it has few leaves).*	*1. Determine if there are sufficient data to support nomination as a biocontrol target; if so nominate.* *2. Perform an initial survey, especially to find the rust pathogen so that testing on Australian accessions of the weed can be performed to determine if there are any genotype matching issues.* *3. Perform preliminary tests on ornamental Gladiolus spp. grown in Australia to obtain a key indication of host-specificity before embarking on a comprehensive host-specificity testing program.*	*n/a*
Prevent it from forming extensive, dense infestations that will cause lost production and seriously impact property management. Make it affordable to manage using existing chemical and mechanical control tools.	*Low*	*Considering the number of closely-related species, especially in the Rosa genus, it is very unlikely that sufficiently host-specific agents could be found, unless pathogens like rust fungi are investigated.*	*Low*	*A hardy host that would likely require a suite of damaging agents to reduce density of infestations.*	*Low*	*Low prospect of finding sufficiently host-specific agents because of the weed's close-relationship with ornamental roses. Would likely require a suite of damaging agents to reduce density of infestations.*	*1. Determine if there are sufficient data to support nomination as a biocontrol target; if so nominate.* *2. Conduct survey in native range for pathogens, as they are the most likely options to achieve the level of host-specificity required.*	*n/a*
Prevent it from forming extensive, dense infestations that will cause lost production and seriously impact property management. Make it affordable to manage using existing chemical and mechanical control tools. Slow the spread to other areas by reducing seed outputs.	*Low*	*Considering previous extensive work, the possibility of finding new host-specific agents in areas that have not been surveyed in Europe is low.*	*Low*	*Hardy target with limited prospect of finding new agents that would cause extensive defoliation over several years and/or attack crowns to significantly reduce density and biomass of infestations.*	*Low*	*Low prospect of finding new agents that are sufficiently host-specific and damaging to have a significant impact on populations.*	*1. Assess research undertaken so far on the purple blotch fungus, Septocyta ruborum, and the likelihood of finding pathotypes that will solely attack invasive Rubus spp.* *2. Perform a survey for new natural enemies in the UK where the most important species, R. anglocandicans, putatively originates from.*	*A Phytophthora sp. has been linked with the extensive, naturally-occurring dieback of invasive blackberries observed in riparian areas in south-west WA (39 km of river bank affected). Consider developing a non-commercial augmentative biocontrol approach based on this pathogen to deploy in major infestations, since it is unlikely that there would be a market potential for a commercial bioherbicide.*

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n/a	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*
Improve livestock carrying capacity by reducing population density and competitive ability.	*Low*	*No new agents expected to be found in the native range that could enhance existing biocontrol.*	*Low*	*Biocontrol program established many years ago and indications is that it is having a major impact.*	*Low*	*Biocontrol program established many years ago and having a major impact. No new agents expected to be found in the native range that could enhance existing biocontrol.*	*No actions identified.*	*Develop extension activities targeting farmers to facilitate/enhance integration of biocontrol agents with other weed management methods.*
Improve livestock carrying capacity by lowering pasture toxicity and increasing pasture production by reducing population density and competitive ability. Grazing management is not dictated by weed (through reduced competition), thus improving farm management operations. Slow the spread to other areas by reducing seed outputs.	*Low*	*Prospect of finding host-specific agents is low as the weed is very closely-related to Australian native Senecio spp. Pathogen agents may be the only option.*	*Low*	*Weed already being attacked by natural enemies of native Senecio spp. and seems to be tolerant of quite a lot of damage.*	*Low*	*A challenging biocontrol target because of its closeness to native Senecio spp. and apparent ability to cope with high levels of damage from natural enemies.*	*1. Continue surveys for natural enemies in South African native range to identify promising candidates.* *2. If candidates are found, perform preliminary host-specificity testing on key native Senecio spp. to determine their potential for biocontrol in Australia.*	*n/a*
Prevent future impacts on livestock carrying capacity by prevent it from becoming dominant across extensive pastures.	*Low*	*Likely to find further Senna specialists, but finding sufficiently host-specific insects for Australia seems unlikely.*	*Low*	*Low based on absence of potential agents.*	*Low*	*Further potential agents is unconsidered unlikely, in part owing to high host-specificity requirements.*	*1. Gap analysis of previous survey efforts, with possibility of a few more years of targeted survey work in Central America. Possibly target pathogens with higher likelihood of specificity.*	*n/a*
Improve livestock carrying livestock capacity by reducing population density and competitive ability. Slow the spread to other areas by reducing seed outputs.	*Low*	*There are some prospects of finding highly host-specific insect agents considering the rich fauna in the native range and preliminary assessments undertaken. However, priority should be given to potential agents known to be highly-specific such as mites and fungal pathogens. Surveys in unexplored regions of Argentina and Chile may reveal additional candidate agents.*	*Mod*	*Evidence from South Africa that severe and continuous defoliation can have a major impact on the weed, even though it has an extensive root system. On this basis, it may be possible to find sufficiently damaging agents.*	*Low-Mod*	*A challenging biocontrol target because of its closeness to economically important and native Solanum spp. There is however, evidence from South Africa that it can be successfully control by defoliating agents.*	*1. Carry out additional surveys for natural enemies if the precise origin of Australian populations in the native range, which is currently being identified in an international genetic study, corresponds to regions that have never before been explored.*	*n/a*
Grazing management not dictated by weed (through reduced competitiveness)	*Low*	*Relatively well surveyed. High host-specificity requirements that have not yet been met.*	*Low*	*Expected to be difficult to find sufficiently damaging agents, based on previous work on Sporobulus, as well as on Nasella.*	*Low*	*Further options for surveying, but likelihood of finding sufficiently host specific and damaging agents remains lows.*	*1. Gap analysis of previous survey efforts and further delimitation of native ranges, potentially leading to further searches in Asia and the USA (and possibly southern Africa). This would include taxonomic work to confirm the species we have in Australia, and to help delimit their native ranges.*	*Explore whether Nigrospora oryzae, which causes crown rot of Sporobulus spp., can be developed into a non-commercial augmentative biocontrol approach to deploy in major infestations, since it is unlikely that there would be a market potential for a commercial bioherbicide.*

Primary goal(s) of biocontrol program based on current situation	Feasibility of undertaking biocontrol program (unfeasible, low, Moderate, high) (see guidelines) If unfeasible do not progress further	Feasibility rationale	Likelihood of success of biocontrol program (low, Moderate, high) (see guidelines)	Likelihood rationale	Biocontrol prospects to mitigate impact (low, Moderate, high) (see guidelines)	Biocontrol prospects explanation	New agents–Key investment area(s) (Possible actions to change rankings of biocontrol feasibility and/or likelihood of success)	Existing natural enemies/released agents–Potential investment area(s) (Possible actions to enhance impact of existing agents)
Grazing management not dictated by weed (through reduced competitiveness)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Grazing management not dictated by weed (through reduced competitiveness)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Grazing management not dictated by weed (through reduced competitiveness), prevent it from becoming dominant under "good" grazing management practice	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A
Grazing management not dictated by weed (through reduced competitiveness)	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A	#N/A

Primary goal(s) of biocontrol program based on current situation	Feasibility of undertaking biocontrol program (unfeasible, low, Moderate, high) (see guidelines) If unfeasible do not progress further	Feasibility rationale	Likelihood of success of biocontrol program (low, Moderate, high) (see guidelines)	Likelihood rationale	Biocontrol prospects to mitigate impact (low, Moderate, high) (see guidelines)	Biocontrol prospects explanation	New agents–Key investment area(s) (Possible actions to change rankings of biocontrol feasibility and/or likelihood of success)	Existing natural enemies/released agents–Potential investment area(s) (Possible actions to enhance impact of existing agents)
Grazing management not dictated by weed (through reduced competitiveness)	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*
n/a	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*
Grazing management not dictated by weed (through reduced competitiveness)	*Low*	*Poorly studied in its native range, but expect natural enemies to be depauperate.*	*Low*	*Expected to be difficult to find sufficiently damaging agents based on precedence of other grasses.*	*Low*	*Poorly studied species but, in the absence of further study, expect it to be a difficult target.*	*1. Nominate as target. 2. Conduct review of available information, and prioritise actions for a biocontrol program.*	*n/a*
n/a	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*	*#N/A*
Prevent it from forming extensive, dense infestations that will cause lost production and seriously impact property management. Make it affordable to manage using existing chemical and mechanical control tools. Slow the spread to other areas by reducing seed outputs.	*Low*	*No new agents expected to be found in the native range that could enhance existing biocontrol.*	*Low*	*Few prospects to find new agents capable of causing major damage, since all options have been investigated.*	*Low*	*All possible available agents have already been released and having some impact, although spread has been slow for some.*	*No actions identified.*	*Distribute the most promising agent, soft shoot moth, which is slow to build up populations and spread, to areas of south-eastern Australia where it is not present. Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers. Investigate the natural dieback that has recently been observed in Tas and assess if this could be exploited to enhance biocontrol*

Primary goal(s) of biocontrol program based on current situation	Feasibility of undertaking biocontrol program (unfeasible, low, Moderate, high) (see guidelines) If unfeasible do not progress further	Feasibility rationale	Likelihood of success of biocontrol program (low, Moderate, high) (see guidelines)	Likelihood rationale	Biocontrol prospects to mitigate impact (low, Moderate, high) (see guidelines)	Biocontrol prospects explanation	**New agents–Key investment area(s)** (Possible actions to change rankings of biocontrol feasibility and/or likelihood of success)	**Existing natural enemies/released agents–Potential investment area(s)** (Possible actions to enhance impact of existing agents)
Improve livestock carrying capacity in invaded grasslands by reducing cover (primarily in Mitchell grasslands in QLD). Reduce control costs and increase ability to prevent spread across potential range.	*Mod*	*Native range now comprehensively surveyed. Only three more potential agents (of unknown host-specificity and unable to be reared). Further survey work not expected to yield additional agents.*	*Low*	*Would generally be considered to be a difficult target and existing agents have failed to reach high densities across the climatic range. Impact of remaining potential agents is not known, but would require high levels of prolonged attack.*	*Low-Mod*	*Only three remaining potential agents, all leaf-feeders of unknown host-specificity which currently can't be cultured. Impact will probably require high levels of prolonged defoliation.*	*1. Finalise testing of 3 remaining potential insects, and follow through if expected to cause required impact and are safe.* *2. Critically assess past exploration/testing work to determine whether other options are available.*	*Redistribution not required. No actions identified. Explore whether natural dieback phenomenon can be exploited.*
Grazing management is not dictated by weed (through reduced competitiveness), thus improving farm management operations.	*Unfeasible*	*Because of its palatability when young, it is most likely that a conflict would occur should this species be proposed as a biocontrol target.*	*n/a*	*n/a*	*Unfeasible*	*Unsuitable for classical biocontrol. Desirable fodder at some times of the year.*	*No actions identified.*	*n/a*
Improve farm management operations (livestock movement) by reducing patch size, population density and biomass. Reduce the need and/or frequency of other weed management tactics by lowering recruitment of the weed.	*Low*	*All known, host-specific insect agents from USA and Mexico have already been released. Additional agents may be found in other regions of Central and South America since they have been unexplored. It will remain a challenge to find compatible rust genotypes better adapted to hot/dry climates to enhance biocontrol in areas where the rust is currently not effective in*	*Low*	*Few prospects to find suitable new agents. Defoliation and stem attack prior to flowering has been shown to be efficient in reducing populations. Weed is often ephemeral along water courses and this has been one of the problems for populations of agents to sustain themselves.*	*Low*	*There are limited options to enhance biocontrol of this weed, especially because of its ephemeral nature. New agents or rust strains would need to be well adapted to hot/dry climates where biocontrol is not currently effective.*	*1. Carry out a survey in Central and South America to identify new potential agents.*	*Survey southern USA for compatible strains of the rust fungus that already occurs in Australia, which could be better adapted to hot/dry climates. Existing insect agents have limited impact and the existing rust strain has reached it eco-climatic limits, therefore redistribution of those agents likely to have limited benefit.*
Improve farm management operations (livestock movement) by reducing patch size, population density and biomass. Reduce the need and/or frequency of other weed management tactics by lowering recruitment of the weed.	*Low*	*Considering previous work, the possibility of finding new agents not previously considered is low. Stem-borer and stem-miner insects found in Argentina and Chile in the 1990s that have not been investigated may have potential, although may be found not to be sufficiently host-specific.*	*Low*	*Few prospects to find new agents capable of causing major damage since most options have been investigated. Defoliation only, without stem attack, would not be sufficient to control plants unless they are associated with a vigorous pasture.*	*Low*	*There are limited options to enhance biocontrol of this weed considering the amount of efforts that have already been expanded.*	*1. Collect stem-borer and stem-miner insects found in Argentina and Chile in the 1990s.* *2. Perform preliminary host-specificity tests, especially on sunflower, to determine if they have any potential for biocontrol.*	*Consider developing a non-commercial augmentative biocontrol approach to enhance the efficacy of the existing Colletotrichum orbiculare pathogen that affects the weed, since the market potential for a commercial bioherbicide is too low to justify costs of development.*
Improve livestock carrying capacity through reduced density. Make management through other means more achievable (including through preventing re-establishment following control work). Slow the spread into unaffected at-risk areas.	*Mod*	*Expect a relatively rich fauna, although may have trouble with host-specificity requirements.*	*Low*	*Expected to be a difficult target, although reducing spread rates is a relatively modest objective. Likelihood of success might increase subject to results from targeted surveys.*	*Low-Mod*	*A largely unexplored target. Expect to find potential agents, but too early to properly assess likelihood of success.*	*1. Assess whether biocontrol is better than diligent targeting of large-seeding trees.* *2. Assess potential for targeting biocontrol to reduce seed production.*	*n/a*

BIOCONTROL ASSESSMENTS WORKSHEET

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Andropogon gayanus		-	Socioeconomic value	It is still valued by a small number of graziers in the Top End. However, most of the grazing industry views it as being an inferior feed stock (unless grown specifically as hay?) which is difficult to manage in open grazing situations, and poses unacceptable fire risks. Causing serious impacts and threat to infrastructure, etc, and greatly increasing fire management costs in heavily invaded areas.	N	Weed life cycle	Perennial grass (expected to be an easier target then annuals). Short-lived seed bank (few seeds survive more than one year?) is advantageous. Goal for BC is relatively modest (reduction of biomass).				*n/a*
Andropogon gayanus		-	Nomination as target for BC	Nomination as target for BC drafted (by CSIRO), but approval from NT still being sort to progress to consultation phase. Current indications are that potential conflicts can be overcome in order to get endorsement from AWC (nomination has been drafted). Risks remain that pushback from stakeholders in the NT will prevent it from getting approved. If not able to process in NT, then Qld could nominate.	-	Type, severity, duration damage	It does senesce seasonally (late dry season) but quickly responds to first rains. This is not necessarily a problem if agents attack plant base or are adapted to seasonality (which would be expected). Wet-dry season in the Top End is extreme, but inter-year climatic variation is low. Difficult to assess in absence of any knowledge of natural enemies, although would expect any agents that damage the base or can substantially reduced vegetative parts would have potential. Agents that dramatically reduce reproduction may also be useful for slowing spread, especially given short seed bank longevity.				
Andropogon gayanus		+	Investment opportunities	Wide range of sectors negatively impacted (environment, fire management, property protection, community). WONS.	-	Synchronicity	Will depend a lot on potential agents. Reproductive feeders will need to be adapted to ?short reproduction season [what?, check lit], which can be difficult for multi-voltine species.				
Andropogon gayanus		+	Logistical - native range	Large native range with parts having reasonably good access.	-	Sensitiveness to damage	Insufficient information to assess				
Andropogon gayanus		+	Logistical - R&D infrastructure & collaborative links	Access is possible. Research infrastructure and expertise is relatively limited in East and West Africa, but some links are there (e.g. CSIRO, USDA). Relationships will require development.	N	Habitat	No knowledge. Expected to be similar conditions somewhere across extensive native range.				
Andropogon gayanus		N	Ecology - weed origin	There is considerable morphological diversity, both in native range and as a result of agronomic work. Australian infestations include at least two morphotypes. Genetic and taxonomic work is probably required to determine exactly what is present in Australia, and	N	Climate	Expect similar climate to occur somewhere within extensive native range.				

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Andropogon gayanus		+	Ecology - knowledge of weed	Ecologically very well studied in Australia. Considerable agronomic work has been done here and overseas. However, it is poorly known ecologically in its native range beyond original pasture exploration work [is that true?]	N	Parasitism/predation	No information.				
Andropogon gayanus		N	Relatedness to non-targets in Australia	There is one [two?] native Andropogon in Australia. There is one other exotic species, but it is a weed of no value.	N	Others	Contiguous host in Top End advantageous.				
Andropogon gayanus		N	Knowledge of natural enemies	CIAT surveys of pests and diseases done in Africa (from the perspective of pasture research, not classical biocontrol), but should be viewed as very preliminary							
Andropogon gayanus		N	Richness & HS of potential agents	No potential agents identified yet, but not specifically seached for. Some natural enemies have been recorded off gamba grass in its native range (CIAT), quite a few organisms identified including fungi [add some detail]							
Andropogon gayanus		N	Other factors	There may be the possibility of biocontrol of leaf-litter, which would help reduce late dry-season biomass (fuel loads), but this would be "blue sky" research which would require locating specialist detritivores.							
Andropogon gayanus	*Andropogon gayanus*	Low	SUMMARY	Potential resistance to BC still needs to be assessed and if possible resolved. No known host specialists, although specific searches have not been made. Feasibility would increase once approved as a target for BC, and subject to results from preliminary native-range work.	Low	SUMMARY	Ranked as low on the basis that grasses have historically been difficult targets, and on the lack of knowledge about the plant and its natural enemies in its native range. However, its' ecology, and early success on a structually similar high biomass grass (Arundo donax) suggests it may nonetheless be promising target.	Low	Several barriers to successful biocontrol, but good reasons to suggest that these could be addressed and overcome within a reasonable time span.	1. Obtain support as target for biocontrol, including conducting necessary stakeholder consultation. 2. Preliminary surveys to determine extent of native range (including of relevant "sub species") and their natural enemies.	n/a
Arctotheca calendula		-	Socioeconomic value	Valued as pasture in WA, but not in Eastern Australia. Flowers valued by beekeepers. However, it provides vital shelter for red-legged earth mites, and thus encourage the most important pasture pest of southern Australia.	N	Weed life cycle	Annual. Flowers very early in annual cycle. Seed germinate in autumn/winter. Dies off with onset of summer.				
Arctotheca calendula		-	Nomination as target for BC	Not nominated.	-	Type, severity, duration damage	Damage will need to occur on an annual basis. Seed long lived.				
Arctotheca calendula		N	Investment opportunities	Mainly a weed of grazing. Reducing its abundance would be beneficial for management of another pest (red-legged earth mite)	N	Synchronicity	Potential agents would need to oversummer for survival every year.				

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Arctotheca calendula		+	Logistical - native range	Southern Africa. No problem with access, especially South Africa. No problem with exporting natural enemies.	N	Sensitiveness to damage	Unknown. Damage on foliage or roots by biocontrol agents combined with grazing management and vigorous pasture should be efficient to reduce its competitiveness				
Arctotheca calendula		+	Logistical - R&D infrastructure & collaborative links	Long-established collaborative links with world-leading government agency and universities that work on biocontrol of weeds	N	Habitat	Mainly in pasture and occasionally as a ruderal weed following soil disturbance. In native habitat also in areas of soil disturbance.				
Arctotheca calendula		+	Ecology - weed origin	Southern Africa. No doubt about origin. May need to perform genetic study to pin point more precise origin to streamline exploration for candidate agents.	+	Climate	Primarily Mediterranean in Australia and native habitat, South Africa, so expect a good climate match for agents.				
Arctotheca calendula		-	Ecology - knowledge of weed	Basic knowledge available. However, there is suspicion that there may be two different forms in eastern and western Australia. Eastern form produced stolons and this may explain why it is considered as more weedy in eastern Australia.		Parasitism/predation					
Arctotheca calendula		+	Relatedness to non-targets in Australia	No relative in the same genus in Australia. The subtribe it belongs to is poorly represented in Australia-only one genus, *Cymbonotus,* which is in a very different to *Arctotheca* (only two native species within genus).		Others					
Arctotheca calendula		+	Knowledge of natural enemies	Knowledge good. Survey of about 25 sites previously done in South Africa (Scott & Way 1996).							
Arctotheca calendula		+	Richness & HS of potential agents	Damaging agents known (chrysomelids and weevils). A nematodes that causes galls recorded in South Australia. All only recorded on the weed so a good indication that they are potentially specific							
Arctotheca calendula			Other factors								
Arctotheca calendula	*Arctotheca calendula*	Low	SUMMARY	A desirable pasture plant for farmers in WA, so likelihood of undertaking biocontrol limited because of expected opposition. Good potential agents known, likely to be host-specific. However, to overcome possible conflict with those who value it, agent(s) will need to be specific toward the putatively different weedy form found in eastern Australia.	Mod	SUMMARY	Unlikely that damage will occur early enough in the growing season to prevent seeding. Damage that reduces competitive ability would be required every year since it is annual species with long-lived seed.	Low-Mod	The main initial barrier to biocontrol is the possible conflict between those who value the plant in WA and others who consider it weedy in the eastern states.	1. Perform a genetic study to determine if there are differences between the putative eastern and western forms of the weed to decide if biocontrol is a viable option considering potential conflict between eastern and western graziers.	n/a
Asphodelus fistulosus		+	Socioeconomic value	None	+	Weed life cycle	Annual to short-lived perennial herb reproducing by seeds. Seeds can germinate at any time of the year				

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Asphodelus fistulosus		-	Nomination as target for BC	No. Data lacking to demonstrate that it causes significant losses and therefore prospect for it to be nominated as a target for biocontrol is low.	+	Type, severity, duration damage	Under optimal conditions, the rust fungus reported to be capable of causing major defoliation on establishing and killing young plants. Even if less damage is observed in the field, once it is combined with appropriate grazing management and vigorous pastures, the plant competitiveness should be greatly reduced.				
Asphodelus fistulosus		-	Investment opportunities	Mainly a weed of grazing.	-	Synchronicity	Given that it inhabits dry seasonal environments, it most likely wouldn't have the continuous that is ideal for some agents.				
Asphodelus fistulosus		+	Logistical - native range	Europe. No access difficulties. No problem with exporting natural enemies.	-	Sensitiveness to damage	Unknown.				
Asphodelus fistulosus		+	Logistical - R&D infrastructure & collaborative links	Australian laboratory in Southern France with necessary R&D infrastructure. A range of collaborative links have been established over the years between Australian and European scientists.	N	Habitat	Dry sandy soils of south-eastern Australia and southern WA. Primarily disturbed areas. Similar to native range.				
Asphodelus fistulosus		N	Ecology - weed origin	Mediterranean-Eurasian origin. Precise region where Australian introductions came from unknown.	-	Climate	Mediterranaean, semi arid to subhumid warm temperate in Australia, however, native range is primarily Mediterranean, hence there is a possible climate mis-match for agents for part of the range.				
Asphodelus fistulosus		N	Ecology - knowledge of weed	Basic biology known, but otherwise limited knowledge. Its genetic structure in Australia is unknown.		Parasitism/predation					
Asphodelus fistulosus		N	Relatedness to non-targets in Australia	Belongs to the family Xanthorrhoeaceae (formerly placed in Liliaceae). There are several Australian native species in this family, mostly in different subfamilies to that of *Asphodelus* spp. No native in the *Asphodelus*		Others					
Asphodelus fistulosus		-	Knowledge of natural enemies	Limited. Only ad hoc and non-comprehensive surveys performed so far.							
Asphodelus fistulosus		+	Richness & HS of potential agents	No arthropods that merited further work identified during surveys. The rust fungus, *Puccinia barbeyi* is promising as it was found to be highly specific in preliminary host-specificity tests. It is unknown if the rust has pathotype specialised on different forms/genotypes of the weed.							
Asphodelus fistulosus			Other factors								

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Asphodelus fistulosus	*Asphodelus fistulosus*	Mod	SUMMARY	Nomination as a target for biocontrol will remain a challenge until more data on its impact are gathered. Good prospect to find a host-specific rust strain since it did not infect a congener species in preliminary testing. No other known potential agents, although comprehensive surveys have not been performed.	Mod	SUMMARY	Rust fungus may cause sufficient damage on plants in the field to sufficiently reduce competitiveness, but may not be effective across all climatic conditions where the weed occurs.	Mod	The main barrier to the initiation of a biocontrol program is the current lack of data on impact of the weed to support a nomination as a biocontrol target. There is good prospect of finding a host-specific rust strain that would cause sufficient damage on the weed across part of its range.	1. Determine if there are sufficient data to support nomination as a biocontrol target; if so nominate. 2. Test rust strains on Australian accessions of the weed to determine if there are any genotype matching issues. 3. Conduct preliminary tests on a few key native species in the Xanthorrhoeaceae family before embarking on a comprehensive host-specificity testing program.	n/a
Bryophyllum delagoense		+	Socioeconomic value	Very minor value as an ornamental	N	Weed life cycle	Two year life cycle, vegetative and seed reproduction, hybrids important				
Bryophyllum delagoense		+	Nomination as target for BC	Approved.	+	Type, severity, duration damage	Both weevils are stem borers which cause severe damage in the laboratory.				
Bryophyllum delagoense		N	Investment opportunities	Possibility of mining interests	+	Synchronicity	Both weevils should synchronize well in new range				
Bryophyllum delagoense		N	Logistical - native range	Endemic to Madagascar which is accessible and relatively easy to survey	+	Sensitiveness to damage	Succulent plant likened to cacti which have been good targets historically.				
Bryophyllum delagoense		N	Logistical - R&D infrastructure & collaborative links	Poor infrastructure, but potential collaborative links exist, and work can be done out of South Africa.	N	Habitat	Found under trees in poor soils, drought tolerant. Similar in native range.				
Bryophyllum delagoense		+	Ecology - weed origin	Genus endemic to madagascar.	N	Climate	Reasonable climate match				
Bryophyllum delagoense		N	Ecology - knowledge of weed	Some knowledge including in the native range	+	Parasitism/predation	Wouldn't expect parasities (weevils internal feeders and there are no close relatives)				
Bryophyllum delagoense		-	Relatedness to non-targets in Australia	Host specificity requirements high due to ornamental Kalanchoes, but could potentially be overcome by BCA (xxx, c $20mill/yr nursery industry). This would be the first time the BC Act has been used in 15 years.		Others					
Bryophyllum delagoense		-	Knowledge of natural enemies	Arne Witt did comprehensive surveys in Madagascar on target species as well as on other species in the genus. The only other option would be to look on other closely related genera in Africa.							
Bryophyllum delagoense		-	Richness & HS of potential agents	Fauna depauperate, with no host-specialists found.							
Bryophyllum delagoense		-	Other factors	Testing of 2 weevils has been completed, but release depends on BCA approval. A thrips has probably realised its potential for impact							

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Bryophyllum delagoense	*Bryophyllum delagoense*	Low	SUMMARY	Two weevils impact important nursery species and their release is therefore dependent on a Benefit-Cost Analysis and use of the Biological Control Act. Unlikely to find further host-specific agents.	Mod	SUMMARY	Stem-borers are expected to be able to cause the required damage, provided they reach sufficient densities across the at-risk area.	Low-Mod	Potential agents are limited to 2 stem-boring weevils. The Biocontrol Act will need to be used to gain approval for release because of host range issues.	1. Follow the two tested beetle species through the Biocontrol Act. This would require quantification of actual and potential impact of the target (and non-targets). 2. Critically assess past exploration/testing work to determine whether other options are available.	No actions identified.
Calotropis procera		+	Socioeconomic value	Little socio-economic value, although some value as drought feed for cattle.	N	Weed life cycle	A perennial species. Fruiting cycle has not been documented. Seed bank relatively short (1-2 yrs) provided sufficient rains for germination. A very good disperser, with seeds able to be spread long distances by wind				
Calotropis procera		-	Nomination as target for BC	Case currently being prepared by QDAFF.	-	Type, severity, duration damage	Unknown				
Calotropis procera		-	Investment opportunities	Not currently considered as a significant environmental weed	N	Synchronicity	knowledge currently limited to seed feeders which may be synchronised				
Calotropis procera		N	Logistical - native range	Occurs from northern Africa to India, some of which is easily accessible.	-	Sensitiveness to damage	In the field plants can withstand heavy browsing damage from livestock. TWRC have conducted herbivory studies which show that the plant is susceptible (details required).				
Calotropis procera		N	Logistical - R&D infrastructure & collaborative links	Infrastructure and collaborative links are good in India, poor elsewhere. Some regions are inaccessible (Sudan).		Habitat	Expected to be similar in native range.				
Calotropis procera		-	Ecology - weed origin	Work required to determine origin. Fruit looks similar to plant in India. Its "native range" is hard to define as it has long been used medicinally and for religious purposes.	N	Climate	Wide climate range in Australia under which BC would have to work. Likely to be similar in native-range.				
Calotropis procera		N	Ecology - knowledge of weed	A lot of agronomy work in subcontinent (commercial growing). Ecology being studied in Australia	-	Parasitism/predation	Unknown				
Calotropis procera		+	Relatedness to non-targets in Australia	No natives in the genus or subtribe		Others	Sudan: some (anecdotal?) evidence that fruit flies have stopped its spread (but different type of fruit there)				

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Calotropis procera		+	Knowledge of natural enemies	Never specifically surveyed for biocontrol agents. Nonetheless, it is a prominent plant in its native range and diverse natural enemies have been recorded (c 100 known), including from Saudi Arabia and India. Deliberate surveying might reveal more potential agents, as might reidentification of old survey work. Several pathogens (including rusts) have been reported from it in its introduced range (South America), suggesting native-range pathogen surveys may be worthwhile.							
Calotropis procera		+	Richness & HS of potential agents	Diverse natural enemies. About 3 are currently thought to be host-specific (all fruit/seed feeders), and there is a reasonable expectaction that further surveying might reveal more species [check RvK WA report]. Might expect co-evolved species on specialist plant chemistry, although this hasn't been the case for other targets (e.g. bellyache bush)							
Calotropis procera			Other factors								
Calotropis procera	*Calotropis procera*	Mod	SUMMARY	Based on existing known agents, and the avenues for finding more, although native-range still needs to be properly delimited (through taxonomic work) and may include inaccessible regions.	Mod	SUMMARY	No reason to believe that it will be a particularly difficult target provided more potential agents can be found. Low likelihood if only multi-voltine seed/fruit feeders are available as they have a poor track record on their own for perennials. The climatic diversity of the target region (northern Australia) may necessitate multiple agents.	Mod	Likely to be find host-specific agents. Goals for biocontrol are relatively achievable provided the right types of agents can be found.	1. Better understand potential impact of the weed, including relationship to grazing management regimes, and longevity of existing infestations. 2. Assess existing potential agents against likelihood of impact, prior to host-range testing. 3. Conduct native-range surveys, once it has been established.	n/a
Carduus nutans		+	Socioeconomic value	None	+	Weed life cycle	Short lived perennial.				
Carduus nutans		+	Nomination as target for BC	Yes. All Carduus spp. nominated in 1986.	+	Type, severity, duration damage	Agents released considerably reduce seed outputs which in turn reduce population density to low levels				
Carduus nutans		-	Investment opportunities	Mainly a weed of grazing. The perception is that C. nutans has been successfully controlled by the three insect agents released (especially the root crown weevil), although the benefits have not been evaluated/quantified. No more agents deemed necessary.	+	Synchronicity	No issue.				
Carduus nutans		+	Logistical - native range	No impediment to access, although exploration can be more challenging in North Africa.	+	Sensitiveness to damage	Plants are very susceptible to early damage.				

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Carduus nutans		+	Logistical - R&D infrastructure & collaborative links	Australian biocontrol program was built on research carried out in the native range as part of the North American and New Zealand biocontrol programs.	-	Habitat	Restricted to high rainfall zone fertile pastures, which are currently being turn more and more to grain production where these weeds will be less of a problem.				
Carduus nutans		+	Ecology - weed origin	Clearly understood as Western/Southern Europe and North Africa.	N	Climate	More prevalent in wet years, especially in fertile pastures. Agents released have widely estblished.				
Carduus nutans		+	Ecology - knowledge of weed	Ecology of the weed well-understood as a result of research as part of the biocontrol program.	+	Parasitism/predation	None				
Carduus nutans		-	Relatedness to non-targets in Australia	Globe artichoke and only two Australian native species in the tribe Cardueae.		Others					
Carduus nutans		+	Knowledge of natural enemies	Very good due to extensive native range surveys performed by US and Australian scientists.							
Carduus nutans		N	Richness & HS of potential agents	Agents were sufficiently host-specific for the Australian context. R. conicus was found to attack native North American Cirsium spp. years after its release.							
Carduus nutans			Other factors								
Carduus nutans	*Carduus nutans*	Low	SUMMARY	No new agents expected to be found in the native range that could enhance existing biocontrol.	Low	SUMMARY	Biocontrol program established many years ago and indications are that it is having a major impact.	Low	Biocontrol program established many years ago and having a major impact. No new agents expected to be found in the native range that could enhance existing biocontrol.	No actions identified.	Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.
Carduus tenuiflorus and *C. pycnocephalus*		+	Socioeconomic value	None	-	Weed life cycle	Annuals and this may make them harder to control with natural enemies.				
Carduus tenuiflorus and *C. pycnocephalus*		+	Nomination as target for BC	Yes. All Carduus spp. nominated in 1986.	-	Type, severity, duration damage	Reducing densities best achieved by reducing seed set. This would be best achieved by killing plants prior to flowering or at least preventing them to flower.				
Carduus tenuiflorus and *C. pycnocephalus*		-	Investment opportunities	Mainly a weed of grazing.	-	Synchronicity	Many small seed heads are produced early, so reducing seed production is a challenge.				
Carduus tenuiflorus and *C. pycnocephalus*		N	Logistical - native range	No impediment to access, although exploration can be more challenging in North Africa.	+	Sensitiveness to damage	Quite susceptible to early damage. The rosette weevil *Ceutorhynchus trimaculatis* was shown to have a high impact on rosette growth in the native range				
Carduus tenuiflorus and *C. pycnocephalus*		N	Logistical - R&D infrastructure & collaborative links	Collaborative links built as part of early activities could be reinstated.	N	Habitat	Restricted to high rainfall zone fertile pastures, which are currently being turn more and more to grain production and consequently these weeds will be less of a problem.				
Carduus tenuiflorus and *C. pycnocephalus*		+	Ecology - weed origin	Clearly understood as Western/Southern Europe and North Africa.	-	Climate	Problem with the weeds varies with climate and is less noticeable in drought years and less fertile pastures. Range of climates, Mediterranean to temperate, may be an issue for agents.				

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Carduus tenuiflorus and *C. pycnocephalus*		+	Ecology - knowledge of weed	Ecology of the weed well-understood as a result of research as part of previous biocontrol program		Parasitism/predation					
Carduus tenuiflorus and *C. pycnocephalus*		-	Relatedness to non-targets in Australia	Globe artichoke and only two Australian native species in the tribe Cardueae.		Others					
Carduus tenuiflorus and *C. pycnocephalus*		+	Knowledge of natural enemies	Very good due to extensive native range surveys performed by US and Australian scientists.							
Carduus tenuiflorus and *C. pycnocephalus*		+	Richness & HS of potential agents	Rich fauna with all insect species specific towards species in the genus *Carduus* or the tribe Cardueae. None of the insects however have been released. One rust pathogen (*Puccinia cardui-pycnocephali*) was found and released in Australia. Some evidence that the rust contribute to reduce slender thistle densities.							
Carduus tenuiflorus and *C. pycnocephalus*			Other factors								
Carduus tenuiflorus and *C. pycnocephalus*	*Carduus tenuiflorus* and *C. pycnocephalus*	Low	SUMMARY	Candidate insect agents have been identified but all are already known to attack other Cardueae (artichoke and native species) and thus there are no options unless more specific insect biotypes are found.	High	SUMMARY	Based on success observed with *C. nutans* , rosette-feeding insect agents could potentially have a high impact on growth and competitiveness of the weed, especially if combined with pasture competition.	Mod	While crown-feeding rosette agents have been successful for other thistle species, there are no options to enhance biocontrol of this species because of lack of additional specific agents.	1. Perform gap analysis of previous surveys data to better assess chances of finding a host-specific rosette-feeding insect agent.	Rust fungus has likely naturally spread to all suitable sites and redistribution is not necessary. Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.
Carthamus lanatus		+	Socioeconomic value	None.	N	Weed life cycle	Winter annual or rarely biennial. Major flowering in November in WA and in February-March in eastern Australia.				
Carthamus lanatus		-	Nomination as target for BC	No.	-	Type, severity, duration damage	Based on work on the rosette crown-feeding fly it appears that plants can easily compensate for damage. So level of attack on rosettes would need to be high.				
Carthamus lanatus		+	Investment opportunities	Also a weed of cropping. Cereal grain contaminated with saffron thistle seed is liable to a dockage.	-	Synchronicity	Early and severe damage on rosettes would be required to prevent flowering.				
Carthamus lanatus		+	Logistical - native range	Europe. No access difficulties. No problem with exporting natural enemies. Western Asia could be more problematic and thus Europe should be favoured for exploration	-	Sensitiveness to damage	Rosettes can compensate for damage.				
Carthamus lanatus		+	Logistical - R&D infrastructure & collaborative links	Australian laboratory in Southern France with necessary R&D infrastructure. A range of collaborative links have been established over the years between Australian and European scientists	N	Habitat	No particular affinity for soil types, but tends to be less common on sands. Wide range of habitats from grazing land to cultivated fields.				
Carthamus lanatus		N	Ecology - weed origin	Europe and western Asia (Eurasia). Precise region where Australian introductions came from unknown.	-	Climate	Warm temperate, subtropical and semi arid regions. Multiple agents probably needed for the climatic range.				

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Carthamus lanatus		+	Ecology - knowledge of weed	Good knowledge on biology and management (e.g. B Grace's PhD thesis). It consists of two subspecies (*lanatus* and *baeticus*). Genetic study has revealed that there are two distinct groups in NSW, each correlated with the northern and southern regions.		Parasitism/predation					
Carthamus lanatus		-	Relatedness to non-targets in Australia	In the same genus as the crop safflower. Although this is not currently a main crop in Australia, its high-quality oil could lead to a resurgence of the industry.		Others					
Carthamus lanatus		+	Knowledge of natural enemies	A few surveys have been carried out in the native range. Literature on natural enemies of safflower has been useful to rule out unsuitable organisms for biocontrol.							
Carthamus lanatus		-	Richness & HS of potential agents	42 arthropods and 4 fungal pathogens found in native range, but only six insects and two pathogens were investigated on the basis of damage they cause and apparent specificity. Only the rosette crown-feeding fly *Botanophila turcica* was found not to attack safflower.							
Carthamus lanatus			Other factors								
Carthamus lanatus	*Carthamus lanatus*	Low	SUMMARY	Comprehensive surveying across native range completed, and only one candidate agent, the rosette crown-feeding fly, found to be sufficiently specific (i.e. no attack on safflower). Limited prospect to find other agents that do not affect safflower.	Mod	SUMMARY	Plants can easily compensate for damage, so level of attack on rosettes would need to be high. Uncertainty about the ability of rosette crown-feeding fly to cause sufficient damage to reduce populations of the weed.	Low-Mod	Only one possible agent available for biocontrol considering the likely conflict that would occur should agents that affect safflower are proposed for release.	1. Investigate impact of the rosette crown-feeding fly in a plant competition experiment to better assess its potential for biocontrol. 2. If point 1 is promising, then nominate the weed as a biocontrol target. 3. Undertake comprehensive host-specificity testing with the fly.	Consider developing a non-commercial augmentative biocontrol approach to enhance the efficacy of the existing *Phomopsis* spp. pathogens that affect the weed, since the market potential for a commercial bioherbicide is too low to justify costs of development.
Cenchrus pedicellatus and *C. polystachios*		+	Socioeconomic value	None.	-	Weed life cycle	Annual/Biennial/Perennial grass.				
Cenchrus pedicellatus and *C. polystachios*		N	Nomination as target for BC	Not nominated, but wouldn' anticipate any problems in getting it approved.	-	Type, severity, duration damage	Expect that it will require high levels of prolonged damge to main part of plant. Limited precedence for grasses				
Cenchrus pedicellatus and *C. polystachios*		+	Investment opportunities	Predominantly an environmental weed, possibly also cropping.	N	Synchronicity	Would need to deal with wet-dry tropical climate				
Cenchrus pedicellatus and *C. polystachios*		-	Logistical - native range	Wide native range: India accessible but Parkistan and northern Africa may have logistical challenges depending on exact distribution.	-	Sensitiveness to damage	Likely to be highly resilient to browsing.				
Cenchrus pedicellatus and *C. polystachios*		N	Logistical - R&D infrastructure & collaborative links	Ok in parts of India and parts of northern Africa for collaborative links.	N	Habitat	No information.				

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Cenchrus pedicellatus and *C. polystachios*		-	Ecology - weed origin	Origin needs to be delimited. This might require genetic/taxonomic work to confirm what we have in Australia and where it is overseas.	N	Climate					
Cenchrus pedicellatus and *C. polystachios*		N	Ecology - knowledge of weed	Some studies in northern Australia, don't know about native range or pasture-research/agronomy studies	N	Parasitism/predation	No information.				
Cenchrus pedicellatus and *C. polystachios*		-	Relatedness to non-targets in Australia	Heaps of con-geners in Australia (check numbers and relatedness), including very high value species (buffel and birdwoo grass, kikuyu)		Others					
Cenchrus pedicellatus and *C. polystachios*		-	Knowledge of natural enemies	Nothing known of richness/host specificity, but as a grass the default expectaction is that fauna will be depauperate.							
Cenchrus pedicellatus and *C. polystachios*		-	Richness & HS of potential agents	Not known.							
Cenchrus pedicellatus and *C. polystachios*			Other factors								
Cenchrus pedicellatus and *C. polystachios*	*Cenchrus pedicellatus* and *C. polystachios*	Low	SUMMARY	Limited knowledge, low expectation of potential agents that are sufficiently host specific.	Low	SUMMARY	Nothing to suggest that it will be an easier target then other grasses	Low	Expected to be a challenging target with high host-specificity requirements.	1. Nominate as target. 2. Confirm taxonomy/origin. 3. Conduct preliminary native range surveying, perhaps piggy-backed on to other work.	n/a
Chromolaena odorata		+	Socioeconomic value	No economic or social value	N	Weed life cycle	Perennial				
Chromolaena odorata		N	Nomination as target for BC	Not nominated, but no barriers anticipated.	+	Type, severity, duration damage	Previous experience of tip fly shows high level of damage.				
Chromolaena odorata		+	Investment opportunities	Also a potentially important environmental weed.	N	Synchronicity	Resource availability for tip fly is not particularly peaked. Precedence.				
Chromolaena odorata		+	Logistical - native range	Large range in Central and South America, relatively easily accessible.	N	Sensitiveness to damage	Previous experience of tip fly shows high sensitivity.				
Chromolaena odorata		+	Logistical - R&D infrastructure & collaborative links	Good links and infrastructure	N	Habitat	Expect plenty of host to be available for agents soon, now that the eradication program has ended.				
Chromolaena odorata		+	Ecology - weed origin	Well known [genetics?]	N	Climate	Similar to where biocontrol has been effective (Papua New Guinea and East Timor)				
Chromolaena odorata		+	Ecology - knowledge of weed	Well known in invaded range, including South Africa.		Parasitism/predation	Not observed in other areas of release of tip fly.				
Chromolaena odorata		+	Relatedness to non-targets in Australia	There are no crop plants in the tribe Eupatorieae and only two Australian native species: Adenostemma lavenia and Adenostemma macrophyllum		Others					
Chromolaena odorata		+	Knowledge of natural enemies	Reasonable knowledge of fauna, and biocontrol has already been successful overseas.							
Chromolaena odorata			Richness & HS of potential agents	Some host specific agents known, including species that have been used as biocontrol agents elsewhere. One is already being tested by QDAFF (a gall fly), and others available.							

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Chromolaena odorata			Other factors								
Chromolaena odorata	*Chromolaena odorata*	High	SUMMARY	At least several host-specific agents known through biocontrol programmes conducted by other countries.	High	SUMMARY	Effective biocontrol in other countries on the same genotype and in similar environments suggests it will also be effective in Australia.	High	A range of well-studied agents available from overseas, including species that have been effective on the same genotype and under similar conditions.	1. Determine and progress with the most promising agents from overseas (work is already underway).	n/a
Cirsium arvense		+	Socioeconomic value	None.	-	Weed life cycle	Perennial herb. Grows in cooler months, dying back in autumn to re-shoot from root buds. Mixed or sexual and asexual reproduction. High seed production and long-lived seedbank.				
Cirsium arvense		+	Nomination as target for BC	Yes.	-	Type, severity, duration damage	Persistent defoliation required to reduce seed production. High seed destruction likely to be required to reduce seed bank. No precedents from other countries of agents that are effective at significantly reducing seed production.				
Cirsium arvense		-	Investment opportunities	Mainly a weed of grazing, and something cropping.	+	Synchronicity	Released agents seems well synchronised with weed lifecycle.				
Cirsium arvense		+	Logistical - native range	Europe. No access difficulties. No problem with exporting natural enemies. Western Asia and North Africa could be more problematic and thus Europe should be favoured for exploration.	-	Sensitiveness to damage	Unknown. None of the agents released that established in North America and New Zealand have had an impact. This could indicate that plants are not much sensitive to damage or that damage was not high enough.				
Cirsium arvense		+	Logistical - R&D infrastructure & collaborative links	Biocontrol research has been done in USA, Canada and New Zealand over the years. Would be easy to build collaborative links with relevant scientists in these countries	N	Habitat	Wide range of habitats.				
Cirsium arvense		+	Ecology - weed origin	Europe, Western Asia and North Africa. It is considered a weed in its native range.	N	Climate	Cool temperate climate. Confined to areas receiving more than 700mm rainfall. Limited distribution				
Cirsium arvense		-	Ecology - knowledge of weed	Good knowledge of its ecology in North America and New Zealand, but not in Australia. Genetic diversity unknown in Australia.		Parasitism/predation					
Cirsium arvense		-	Relatedness to non-targets in Australia	Globe artichoke and only two Australian native species in the tribe Cardueae. There are no native *Cirsium* spp. in Australia.		Others					

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Cirsium arvense		+	Knowledge of natural enemies	Excellent knowledge gathered during the many surveys carried out as part of the North American biocontrol program. There is a current active program searching for potential pathogens suitable for release as classical agents against this weed. Options to augment the effect of the rust *Puccinia punctiformis* have been investigated in Europe, USA and New Zealand. This rust is already present in Australia.							
Cirsium arvense			Richness & HS of potential agents	Rich fauna. Many natural enemies however, can also attack other C*irsium* spp. (a problem for the USA which has several native spp. in this genus).							
Cirsium arvense			Other factors								
Cirsium arvense	*Cirsium arvense*	High	SUMMARY	Of the extensive number of natural enemies found on this weed in the native range, there are chances that additional agents sufficiently host-specific for the Australian situation could be found, especially considering precedents with *Carduus* and *Onopordum* spp. Pathogen survey currently being undertaken may reveal promising candidate, although note that the rust fungus that attacks this weed is already present in Australia.	Low	SUMMARY	Considering the extensive work done on the biocontrol of this weed and the poor track record of agents released/established in other countries for this weed, which included a stem miner (although no crown/root feeder were ever released), it is legitimate to conclude that it is a difficult target and chances of achieving successful biocontrol are low.	Mod	Good prospect to find additional host-specific biocontrol agents considering that Australia does not have native *Cirsium* spp. However, precedents in other countries indicate that very high levels of damage would be required to control the weed.	1. Wait for results from New Zealand on impact of new agents released or to be released. 2. If point 1 is promising, conduct preliminary host-specificity tests to confirm that they do not attack Australian native species in the tribe Cardueae before any further assessment.	Wait for results from New Zealand on options to enhance the efficacy of the rust fungus *Puccinia punctiformis* on this weed using an augmentative biocontrol approach. If promising, conduct trials in Australia.
Cirsium vulgare		+	Socioeconomic value	None.	-	Weed life cycle	Late-flowering monocarpic biennial or short-lived perennial (rarely annual). High seed production and long-lived seedbank.				
Cirsium vulgare		+	Nomination as target for BC	Yes.	-	Type, severity, duration damage	Persistent defoliation required to reduce seed production. High seed destruction likely to be required to reduce seed bank. Indications are that the rosette feeding agent from *C. nutans* has not established well on *C. vulgare. I* t is expect that such a crown-root feeder would cause the type of damage necessary to enhance biocontrol of the weed.				
Cirsium vulgare		-	Investment opportunities	Mainly a weed of grazing, and something cropping.	+	Synchronicity	Released agents seems well synchronised with weed lifecycle.				
Cirsium vulgare		+	Logistical - native range	Europe. No access difficulties. No problem with exporting natural enemies. Western Asia and North Africa could be more problematic and thus Europe should be favoured for exploration.	-	Sensitiveness to damage	Released seed feeding weevil and fly cause high reductions in seed production but impacts on seedbank and plant demography is unknown.				

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Cirsium vulgare		+	Logistical - R&D infrastructure & collaborative links	Biocontrol research has been done in USA, Canada and New Zealand over the years. Would be easy to build collaborative links with relevant scientists in these countries	N	Habitat	Prefers heavy soils of reasonable fertility. Wide range of habitats.				
Cirsium vulgare		+	Ecology - weed origin	Europe, Western Asia and North Africa.	-	Climate	Subhumid cool-temperate climate. Widespread distribution.				
Cirsium vulgare		+	Ecology - knowledge of weed	Biology well studied. Genetic diversity unknown in Australia.		Parasitism/predation					
Cirsium vulgare		-	Relatedness to non-targets in Australia	Globe artichoke and only two Australian native species in the tribe Cardueae. There are no native *Cirsium* spp. in Australia.		Others					
Cirsium vulgare		+	Knowledge of natural enemies	Extensive surveys for arthropod natural enemies (not pathogens) in native range performed as part of the North American biocontrol program.							
Cirsium vulgare		+	Richness & HS of potential agents	Rich natural enemy complex in native range. The two agents deemed most promising following initial surveys were released in North America, and subsequently in New Zealand and Australia. The rosette weevil, *Trichosirocalus horridus* from *C. nutans* has also been released on populations of *C. vulgare* after it was found that it successfully established on it in New Zealand. The rust fungus *Puccinia cnici* has been investigated but was not released because of the limited damage it causes on plants.							
Cirsium vulgare			Other factors								
Cirsium vulgare	*Cirsium vulgare*	Mod	SUMMARY	Of the extensive number of natural enemies found on this weed in the native range, there are chances that additional agents sufficiently host-specific for the Australian situation could be found, especially considering precedents with *Carduus* and *Onopordum* spp.	High	SUMMARY	Still missing a key agent in the suite released that would attack the crown/root of the weed (seed feeders will not do the job alone). Based on success observed with other thistles, rosette-feeding insect agents could potentially have a high impact on growth and competitiveness of the weed, especially if combined with pasture competition.	Mod-High	Good prospect to find additional host-specific biocontrol agents considering that Australia does not have native *Cirsium* spp. Finding a damaging crown-root weevil would complement existing agents and increase likelihood of achieving successful biocontrol.	1. Investigate the genetics of the weed to identify most appropriate areas of native range to survey to find a crown-root weevil that attack the form of C. vulgare presents in Australia.	Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.
Cryptostegia grandiflora		+	Socioeconomic value	No current value, previously grown as an ornamental	-	Weed life cycle	Perennial, can be deciduous during the dry season. Seedlings emerge in wet season.				
Cryptostegia grandiflora		+	Nomination as target for BC	Approved target.	-	Type, severity, duration damage	Moth required a combination of years to go well. Rust: wayne a lot of unpublished work on assessment of this				
Cryptostegia grandiflora		+	Investment opportunities	Also an environmental weed. WONS.	-	Synchronicity	Agents must be able to survive during the dry season and during drought years.				

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Cryptostegia grandiflora		N	Logistical - native range	Endemic to Madagascar which is accessible and relatively easy to survey	+	Sensitiveness to damage	Sensitive to defoliation during growing season				
Cryptostegia grandiflora		N	Logistical - R&D infrastructure & collaborative links	Poor infrastructure, but potential collaborative links exist, and work can be done out of South Africa.	N	Habitat	High rainfall tropical and subtropical, woodlands and riparian. Likely to be similar to native-range?				
Cryptostegia grandiflora		+	Ecology - weed origin	Endemic to madagascar	-	Climate	High inter-year rainfall variability. Likely to be similar to native-range?				
Cryptostegia grandiflora		+	Ecology - knowledge of weed	Well known in Australia	N	Parasitism/predation	Unknown				
Cryptostegia grandiflora		-	Relatedness to non-targets in Australia	Gymnanthera spp related and slightly affected by current agents		Others					
Cryptostegia grandiflora		+	Knowledge of natural enemies	Comprehensively survyed (Marohasy in Madagascar for 2-3 years).							
Cryptostegia grandiflora		-	Richness & HS of potential agents	Few host-specific natural enemies found. Wouldn't expect to find additional agents.							
Cryptostegia grandiflora			Other factors								
Cryptostegia grandiflora	*Cryptostegia grandiflora*	Low	SUMMARY	Already comprehensively surveyed. Wouldn't expect to find additional host-specific agents.	Low	SUMMARY	Low based on impacts of existing agents, and lack of further host-specific agents. Assessment might change if further potential agents are discovered, and what they were.	Low	Unlikely to find further host-specific agents.	1. Critically assess past exploration/testing work to determine whether other options are available.	Evaluate/quantify the distribution and effectiveness of the two existing agents (a rust and a moth), to determine whether their impact can be increased through redistribution, e.g., around Rockhampton and in the Kimberley. Identify whether there is a need for new biocontrol agents.
Cytisus scoparius		N	Socioeconomic value	Some. Originally introduced as an ornamentals, although not grown as such anymore. Some value for beekeepers	+	Weed life cycle	Perennial shrub. Lives more than 20 years in Australia. High seed production.				
Cytisus scoparius		+	Nomination as target for BC	Yes, before formal nomination process was put in place.	-	Type, severity, duration damage	Large reduction in flowers/seeding is required to decrease the long-lived and abundant seedbank.				
Cytisus scoparius		+	Investment opportunities	Also an environmental weed and a WoNS.	+	Synchronicity	Released agents well synchronised with plant life cycle.				
Cytisus scoparius		+	Logistical - native range	Easy access to Europe and no impediments to exportation of natural enemies.	-	Sensitiveness to damage	High levels of damage recorded from the release agents in some areas, but the plant is not considered to be under control. There is usually a rapid recovery of stands without long-term follow-up due to long-lasting seedbank.				
Cytisus scoparius		+	Logistical - R&D infrastructure & collaborative links	Australian laboratory in Southern France with necessary R&D infrastructure. A range of collaborative links have been established over the years between Australian and European scientists	N	Habitat	Disturbed and undisturbed habitats in sub-alpine areas.				
Cytisus scoparius		+	Ecology - weed origin	Clearly understood as Europe .	N	Climate	Cooler, temperate areas.				
Cytisus scoparius		+	Ecology - knowledge of weed	Well studied as part of biocontrol programs in USA, NZ and Australia. Genetic diversity never explored.	-	Parasitism/predation	High parasitism of the twig-mining moth *Leucoptera spartifoliella* recorded. Some predation recorded on *Aceria* galls but not high.				

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Cytisus scoparius		-	Relatedness to non-targets in Australia	Some important commercial species with the tribe Genisteae, including lupins and tagasaste.		Others					
Cytisus scoparius		+	Knowledge of natural enemies	Surveyed extensively in native range.							
Cytisus scoparius		+	Richness & HS of potential agents	Very rich community of natural enemies. Over 240 insects and mites and many fungi recorded. Four host-specific agents released in Australia. The rust *Uromyces pisi-sativi* was recently found (probably an accidental introduction). Two other insect agents have been released in NZ (the broom moth *Agonopterix assimilella* and the broom leaf beetle *Gonioctena olivacea*), but they also attack tagasaste.							
Cytisus scoparius			Other factors								
Cytisus scoparius	*Cytisus scoparius*	Low	SUMMARY	Comprehensive surveying for natural enemies across native range completed and all available suitable agents have been released in Australia. New Zealand introduced two additional insect agents, but it is unlikely that they would ever get approval for release in Australia because they can attack tagasaste, a valuable fodder crop used in WA.	Low	SUMMARY	Some prospect to enhance biocontrol by introducing additional agents, although the long-lived seedbank and rapid recruitment following stand density reduction, strongly indicate that an integrated weed management approach may be more successful at achieving goals.	Low	Prospect to introduce additional agents is limited because of lack of specificity. Integration of current biocontrol agents with other control methods that specifically target recruitment from the large and long-lasting seedbank following death of adult plants may be a more appropriate approach.	No actions identified.	Distribute Aceria mite agent, which is very slow to spread naturally, into non-contiguous areas where it is not present. Evaluate/quantify the impact of agents released (including the rust that was not an authorised release), assess if impact can be enhanced through IWM and develop recommendations for farmers.
Echium plantagineum		N	Socioeconomic value	Has some value as fodder in drier areas and pollen for honey production. Conflict between stakeholders was resolved with the Biological Control Act in the 1980s	-	Weed life cycle	Annual species. Prolific seeder. Germinates after autumn break in rainfall, which sometimes is late resulting in agent population being greatly reduced.				
Echium plantagineum		+	Nomination as target for BC	Yes.	+	Type, severity, duration damage	Multi-pronged approach by six agents that attack all stages of the plant growth leading to severe damage.				
Echium plantagineum		-	Investment opportunities	Mainly a weed of grazing.	+	Synchronicity	All established agents except one are univoltine and well synchronised with the weed's life cycle.				
Echium plantagineum		+	Logistical - native range	No impediment with access.	+	Sensitiveness to damage	Sensitive to the extensive damage caused by the agents, especially to the crown and root system.				
Echium plantagineum		+	Logistical - R&D infrastructure & collaborative links	Long-term research was comprehensively carried out with good collaborations in Europe.	-	Habitat	Wide range of habitats, including perennial and annual pastures.				
Echium plantagineum		+	Ecology - weed origin	Clearly understood as Mediterranean-Europe .	-	Climate	Temperate to Mediterranean, requiring many agents (as has been the case).				
Echium plantagineum		+	Ecology - knowledge of weed	Ecology of the weed well-understood as a result of research as part of the biocontrol program.	N	Parasitism/predation	Leaf mining moth subject to parasitism. The other five beetles established are reasonably robust.				
Echium plantagineum		+	Relatedness to non-targets in Australia	Belongs to the Boraginaceae family. There are no native *Echium* spp. in Australia.		Others					

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Echium plantagineum		+	Knowledge of natural enemies	Excellent knowledge gained through multi-year surveys in the native range..							
Echium plantagineum		+	Richness & HS of potential agents	Six of the host-specific agents released in Australia have established. One other agent was released but did not established.							
Echium plantagineum		+	Other factors	Released agents are well the way to achieve goal (i.e. reduce vigour and abundance of the weed across Australia)							
Echium plantagineum	*Echium plantagineum*	Low	SUMMARY	No new agents expected to be found in the native range that could enhance existing biocontrol.	Low	SUMMARY	Biocontrol program established many years ago and indications is that it is having a major impact.	Low	Biocontrol program established many years ago and having a major impact. No new agents expected to be found in the native range that could enhance existing biocontrol.	No actions identified.	Assess existing data on impact of released agents and collect additional data if necessary. Assess if impact can be enhanced through IWM and/or further redistribution of agents and develop recommendations for farmers. Revisit initial economic analysis
Emex australis		N	Socioeconomic value	None, although seeds are eaten by cockatoos, an issue that was addressed in original biocontrol program (only 2% of seeds are eaten)	N	Weed life cycle	Annual herb.				
Emex australis		+	Nomination as target for BC	Yes.	+	Type, severity, duration damage	Agronomic studies have proposed a strategy of combining plant damage (via herbivory or diseases) with pasture-crop rotations to achieve weed control.				
Emex australis		+	Investment opportunities	Also a weed of cropping.	+	Synchronicity	Plant produces seed very early in development, however, the long seed development time means that plant stress can be applied to reduce seed dormancy.				
Emex australis		+	Logistical - native range	Southern Africa. No problem with access, especially South Africa. No problem with exporting natural enemies.	-	Sensitiveness to damage	Able to tolerate extensive damage and still produce seed. However experimental evidence points to stress reducing seed dormancy (by reducing seed size).				
Emex australis		+	Logistical - R&D infrastructure & collaborative links	Long-established collaborative links with world-leading government agency and universities that work on biocontrol of weeds	-	Habitat	Found mainly in cropping-pasture rotation systems, ie highly disturbed systems.				
Emex australis		+	Ecology - weed origin	Southern Africa. Congener *E. spinosa,* which is also a weed in Australia, albeit more restricted than *E. australis* , is of Mediterranean origin	-	Climate	Mediterranean climates via deserts through to subtropical, both in native and introduced range. Agents are unlikely to be suitable for all situations				
Emex australis		+	Ecology - knowledge of weed	Weed well studied.	-	Parasitism/predation	Ants are likely to be important predators for external feeding insects and have already played a role in the failure of two released agents to establish.				
Emex australis		-	Relatedness to non-targets in Australia	Belongs to the family Poligonaceae. Related to seven Australian native *Rumex* species.	N	Others	Two natural enemies already present in Australia (probably as a result of accidental introductions) are widespread but don't seem to provide control.				

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Emex australis			Knowledge of natural enemies	Well known, extensive surveys for arthropods and fungi have been performed in Southern Africa and the Mediterranean region over the past 30 years							
Emex australis			Richness & HS of potential agents	Rich fauna considering it is an annual species. Fifteen potentially host-specific agents for *E. australis* and *E. spinosa* were identified, but several were later found not to be sufficiently specific. Three were released in Australia but either failed to establish and/or to have any impact. Other candidates were not pursued further because of lack of apparent impact in the native range and/or difficulties to rear							
Emex australis			Other factors								
Emex australis	*Emex australis*	Low	SUMMARY	Comprehensive surveying of arthropods across native range completed and most options have been investigated. There remains two candidate agents. The weevil *Perapion neofallax* is promising because of its ability to diapause over summer when the weed is not growing in Australia, but major difficulties in rearing it have been encountered in the past. A *Cercospora* leaf pathogen could also be considered for use in biocontrol.	Low	SUMMARY	Weed is able to tolerate extensive damage and still produce seed. It is already being attacked by two natural enemies across its range without providing control. Additional candidate agents have attributes (diapause, spores) that might favour establishment, although their potential impact on the weed is unknown.	Low	Biocontrol program established years ago without any agent becoming established. Potential agents remain to be investigated, but will need to take into account weeds annual lifecycle and dry hot conditions or region infested.	1. Recollect the weevil P. neofallax in Tunisia and develop appropriate rearing techniques so that preliminary testing on native Rumex spp. can be undertaken to assess its potential for biocontrol. 2. Assess Cercospora spp. from Africa.	No actions identified.
Eragrostis curvula		-	Socioeconomic value	serious conflict: released cultivars (Consol) that are being used as pastures for drought fodder and sown to comete with spiny burr grass, cannot be separated from invasive form.		Weed life cycle					
Eragrostis curvula		-	Nomination as target for BC	No, and not feasible.		Type, severity, duration damage					
Eragrostis curvula		N	Investment opportunities			Synchronicity					
Eragrostis curvula		+	Logistical - native range			Sensitiveness to damage					
Eragrostis curvula		+	Logistical - R&D infrastructure & collaborative links			Habitat					
Eragrostis curvula		+	Ecology - weed origin			Climate					
Eragrostis curvula		+	Ecology - knowledge of weed			Parasitism/predation					
Eragrostis curvula		-	Relatedness to non-targets in Australia			Others					
Eragrostis curvula		-	Knowledge of natural enemies								

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Eragrostis curvula		-	Richness & HS of potential agents								
Eragrostis curvula		-	Other factors								
Eragrostis curvula	*Eragrostis curvula*	Unfeasible	SUMMARY	Unfeasible biocontrol target as species can be both problematic and useful as a pasture, depending on setting and cultivar.	n/a	SUMMARY	n/a	Unfeasible	An unfeasible biocontrol target as species can be both problematic and useful as a pasture, depending on setting and cultivar.	No actions identified.	n/a
Euphorbia terracina		+	Socioeconomic value	No value for any industry. Provide no benefit for native fauna and flora.	+	Weed life cycle	Long-lived perennial. History of biocontrol success on *Euphorbia* in USA (eg. leafy spurge)				
Euphorbia terracina		N	Nomination as target for BC	No, but its closely-related species *Euphorbia paralias* (sea spurge) has been recently nominated as a biocontrol target. Based on this, hurdles for nomination are not envisaged.	-	Type, severity, duration damage	Continued defoliation would be required since the plant has a long-lived basal crown. Alternatively an insect that bores into the crown would be desirable.				
Euphorbia terracina		+	Investment opportunities	Also an environmental weed.	+	Synchronicity	Plants are present all year round - a major advantage for biocontrol.				
Euphorbia terracina		+	Logistical - native range	Mediterranean region; second dunes from the coast. Easy access. The plant is a threatened species in Europe because its habitat has been destroyed. Plants however, are found only in highly protected reserves so surveying would be logistically difficult.	-	Sensitiveness to damage	Unknown.				
Euphorbia terracina		+	Logistical - R&D infrastructure & collaborative links	Could build on existing infrastructure/collaboration used for research on sea spurge.	N	Habitat	Associated with calcareous sandy soils, in permanent annual pastures and native vegetation.				
Euphorbia terracina		+	Ecology - weed origin	Limited to Mediterranean region. There is no indication of polyploidy, although this has not been studied in detail.	-	Climate	Restricted to Mediterranean climate; highly restricted in Europe in distribution but more widely distributed in Australia. Restricted native habitat implies that there will be few agents available, wide distribution in Australia implies that more agents would be required for the full range.				
Euphorbia terracina		-	Ecology - knowledge of weed	Small amount of work done on the species in situations where it is an environmental weed. Knowledge gap on its biology most likely. Genetic structure in introduced range not known.	-	Parasitism/predation	Plant associated with ants in Australia (seeds collected by ants); this association could be a problem as some insect agents (external feeders) could be predated on by ants.				
Euphorbia terracina		N	Relatedness to non-targets in Australia	There are many native *Euphorbia* in Australia, but they belong to a different sub-genus. Sea spurge also belong to a different sub-genus than the weed. Host-range of sea spruge pathogens tested was congruent with phylogeny of species within the genus.		Others					

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Euphorbia terracina		-	Knowledge of natural enemies	Has not been surveyed, but is known to be host of the rust *Melampsora euphorbiae* (one of the candidate agents for sea spurge). A trap garden approach would probably have to be used to collect rust strains.							
Euphorbia terracina		-	Richness & HS of potential agents	Unknown							
Euphorbia terracina			Other factors								
Euphorbia terracina	*Euphorbia terracina*	Mod	SUMMARY	Limited knowledge of natural enemies in native range as no surveys have been performed. There are records of the rust *Melampsora euphorbiae* infecting this weed in the native range. Good prospect to find a rust strain that would not pose a threat to Australian native *Euphorbia* spp.	Mod	SUMMARY	High level of defoliation would be required since the plant is a long-lived perennial with a basal crown.	Mod	Good prospect to find a rust strain that would not pose a threat to Australian native *Euphorbia* spp. High level of defoliation would be required since the plant is a long-lived perennial with a basal crown.	1. Determine if there are sufficient data to support nomination as a biocontrol target; if so nominate. 2. Perform an initial survey, especially to find the rust pathogen so that testing on Australian accessions of the weed can be performed to determine if there are any genotype matching issues. 3. Perform preliminary testing on key native Euphorbia spp. to obtain an indication of host-specificity before embarking on a comprehensive host-specificity testing program.	n/a
Harrisia martinii		+	Socioeconomic value	Not valued.		Weed life cycle	Sexual and vegetative propagation, resource is continually available, easy agent dispersal within populations but not between.				
Harrisia martinii		+	Nomination as target for BC	Yes		Type, severity, duration damage	Plants susceptible to secondary infection after stem damage.				
Harrisia martinii		-	Investment opportunities	Not an environmental problem.		Synchronicity	plant parts available over long period				
Harrisia martinii		+	Logistical - native range	Native range well studied, known origin (Argentina, Paraguay)		Sensitiveness to damage	Past success indicate future success for new, but related agents.				
Harrisia martinii		+	Logistical - R&D infrastructure & collaborative links	good infrastructure, excellent collaborative links with Argentina.		Habitat	Individual species have limited ranges in Australia				
Harrisia martinii		+	Ecology - weed origin	Well studied in Australia.		Climate	stable climates similar to native range				
Harrisia martinii		+	Ecology - knowledge of weed	Well described. No taxonomic ambiguities.		Parasitism/predation	Occasional problems				
Harrisia martinii		+	Relatedness to non-targets in Australia	No native cacti		Others	If there is a climatic reason, or bottlenecking of original introduction of mealybug and cerambycid				
Harrisia martinii		+	Knowledge of natural enemies	Comprehensively surveyed in native range							
Harrisia martinii		-	Richness & HS of potential agents	One very effective agent, no other agents known, do not expect to find more							
Harrisia martinii		N	Other factors	Agent doesn't work well everywhere.							
Harrisia martinii	*Harrisia martinii*	Low	SUMMARY	Further agents not expected to be found.	Low	SUMMARY	Low in the absence of knowledge about further agents.	Low	Comprehensively surveyed. No further host-specific agents expected to be found.	1. Critically assess past exploration/testing work to determine whether other options are available.	Determine reason why biocontrol is apparently not as effective in southern Qld and northern NSW. Then identify whether the problem can be overcome, e.g., through additional releases

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Hordeum spp.		-	Socioeconomic value	Serious conflict would occur if this species was targeted for biocontrol. Annual species renowned for rapidly germinating in autumn to provide valuable stock feed soon after breaking rain. Carries diseases that affect wheat (e.g. 'green bridge' for cereal root rot diseases, major host of take-all disease).		Weed life cycle					
Hordeum spp.		-	Nomination as target for BC	No.		Type, severity, duration damage					
Hordeum spp.		-	Investment opportunities	None.		Synchronicity					
Hordeum spp.		-	Logistical - native range	Wide native range; logistical issues cannot be identified without knowing exact region of origin.		Sensitiveness to damage					
Hordeum spp.			Logistical - R&D infrastructure & collaborative links			Habitat					
Hordeum spp.		-	Ecology - weed origin	The genus *Hordeum* has centres of diversity in central and south western Asia, western North America, southern South America and the Mediterranean.		Climate					
Hordeum spp.			Ecology - knowledge of weed			Parasitism/predation					
Hordeum spp.		-	Relatedness to non-targets in Australia	Same genus as barley (*Hordeum vulgare*).		Others					
Hordeum spp.			Knowledge of natural enemies	Insect pests and diseases of barley crop well known and most likely to also affect weedy *Hordeum* spp.							
Hordeum spp.		-	Richness & HS of potential agents	Only options for biocontrol of weedy *Hordeum* spp. would be highly specific pathogen strains.							
Hordeum spp.			Other factors								
Hordeum spp.	*Hordeum* spp.	Unfeasible	SUMMARY	Desirable fodder at some times of the year. Closely-related to barley crop and therefore it would never be endorsed as a candidate for classical biocontrol.	n/a	SUMMARY	n/a	Unfeasible	Unsuitable target for classical biocontrol. Desirable fodder at some times of the year and closely related to barley, a major crop	No actions identified.	n/a
Hyparrhenia hirta		+	Socioeconomic value	No socioeconomic issues. It can be grazed but is of no real value.	-	Weed life cycle	Perennial, seasonal, high biomass grass.				
Hyparrhenia hirta		N	Nomination as target for BC	No, but no barriers anticipated.	-	Type, severity, duration damage	Probably needs to be severe and prolonged.				
Hyparrhenia hirta		+	Investment opportunities	Also an environmental weed	-	Synchronicity	Dry season synchronisation required				
Hyparrhenia hirta		+	Logistical - native range	Southern Africa, but sources also mention Mediterranean, W Asia so not well defined	-	Sensitiveness to damage	Unknown				
Hyparrhenia hirta		+	Logistical - R&D infrastructure & collaborative links	Good links, accessible, in Sout Africa but less so elsewhere	N	Habitat	Wide range of mainly disturbed habitats. Probably similar to the native range.				

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Hyparrhenia hirta		-	Ecology - weed origin	Unknown, requires work to resolve.		Climate	Probably represented in the native range.				
Hyparrhenia hirta		-	Ecology - knowledge of weed	Knowledge of plant is poor, poor taxonomic or genetic understanding, little literature.		Parasitism/predation	Unknown				
Hyparrhenia hirta		-	Relatedness to non-targets in Australia	Two native species in same area as invasive species (check), as well as other exotic of no value.		Others	A poorly studied grass species.				
Hyparrhenia hirta		N	Knowledge of natural enemies	We know nothing of natural enemies.							
Hyparrhenia hirta		N	Richness & HS of potential agents	We know nothing of natural enemies, but as a grass it is expected to be relatively depauperate and relatively few host-specialist species							
Hyparrhenia hirta		-	Other factors								
Hyparrhenia hirta	*Hyparrhenia hirta*	Low	SUMMARY	A poorly studied, unsurveyed, grass species that is expected to have a relatively depauperate fauna.	Low	SUMMARY	A poorly studied grass species that is expected to be relatively resilient to herbivory and damage.	Low	Poorly studied species with native congeners. It is expected, in the absence of further information, to be a difficult target.	1. Determine native-range and conduct preliminary surveys of natural enemies.	n/a
Hypericum perforatum		-	Socioeconomic value	Has medicinal values. Potential use by the drug industry.	N	Weed life cycle	Perennial herb and prolific seeder. Rosette form in autumn and winter. Production of woody flowering stems in spring and summer. Reproduce by seeds and vegetatively from lateral roots.				
Hypericum perforatum		+	Nomination as target for BC	Yes.	-	Type, severity, duration damage	Severe damage on rosettes would be ideal and it would prevent plants producing flowering stems.				
Hypericum perforatum		+	Investment opportunities	Also an environmental weed.	-	Synchronicity	Agents released are often out of synch with the weed.				
Hypericum perforatum		+	Logistical - native range	No impediment with access and exportation of agents.	N	Sensitiveness to damage	Defoliation by the *Chrysolina* beetles can kill deep-rooted plants on good soils but not on shadow, stony soils. On the latter the weed respond to defoliation by producing new shoots vegetatively from lateral roots.				
Hypericum perforatum		+	Logistical - R&D infrastructure & collaborative links	Long-term research was comprehensively carried out with good collaborations in Europe.	-	Habitat	Wide range of soils and habitats across Australia.				
Hypericum perforatum		+	Ecology - weed origin	Europe.	N	Climate	Good climate match for Mediterranean regions, but perhaps less so for more temperate regions. Understanding genotype – climate interaction is necessary for selecting appropriate agents.				
Hypericum perforatum		+	Ecology - knowledge of weed	Ecology of the weed well-understood as a result of research as part of the biocontrol program. Three biotypes in Australia.	-	Parasitism/predation					
Hypericum perforatum		-	Relatedness to non-targets in Australia	There are a few ornamental and two native *Hypericum* spp. in Australia.		Others					

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Hypericum perforatum		+	Knowledge of natural enemies	Target that has been studied over 80 years by various countries.							
Hypericum perforatum		+	Richness & HS of potential agents	High richness. Several host-specific agents were found in the native range and released in Australia. Six have established. The mites only attacks one form of the weed. A *Melampsora* rust was found once in the native range and no investigated due to lack of material.							
Hypericum perforatum			Other factors								
Hypericum perforatum	*Hypericum perforatum*	Low	SUMMARY	Comprehensive surveying of arthropods across native range completed and all options have been investigated. There may be potential specific pathogen agents in the native range that have been overlooked during arthropod surveys. Candidate pathogen agents would need to infect all forms of the weed present in Australia.	Low	SUMMARY	A difficult target considering that it is still a problem in parts of its range despite the large number of agents that have been released. Asynchrony between agents and the weed and/or sub-optimal climatic conditions for agent development may be important factors. Low prospect to find highly damaging and widespread pathogens in the native range, because one would expect that they would have been noticed during the extensive surveys performed over the years.	Low	Low prospects to find additional agents with good potential to enhance biocontrol of this weed across its range.	1. Consider performing an additional survey in the native range specifically targeting potential pathogen agents.	Determine why the beetle Agrilus hyperici has so poorly established in Australia, and, if resolved, rear and distribute this agent in areas where other agents do not perform as well. Evaluate/quantify the impact of all agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers. Investigate the genetics of the weed to identify most appropriate areas of native range to collect more efficient strain(s) of the mite Aculus hyperici. It is most likely that there is a mis-match between the main form of the weed in Australia and the strain of the mite released because damage in Australia is far less severe than in the native range.
Jatropha gossypiifolia		+	Socioeconomic value	None, but *J. curcas* is a potential biofuel crop.	N	Weed life cycle	Perennial species. Relatively long fruiting/flowering season [?]. Can be seasonally deciduous.				
Jatropha gossypiifolia		+	Nomination as target for BC	Approved, together with *J. curcas* .	-	Type, severity, duration damage	Native-range observation show that plants are not heavily damaged, although occasional outbreaks of rust pathogen may occur.				
Jatropha gossypiifolia		+	Investment opportunities	Prospective environmental weed (riparian weed). WONS.	N/-	Synchronicity	Obligatory leaf loss in some parts of Australia which agents would need to be adapted to				
Jatropha gossypiifolia		+	Logistical - native range	Good access to native range, although there are some issues with export permits (Biodiversity Agreement)	-	Sensitiveness to damage	Experimental work revealed insensitivity to damage (Sathymurthy).				
Jatropha gossypiifolia		+	Logistical - R&D infrastructure & collaborative links	Well connected to expertise and infrastructure in Americas	+	Habitat	Similar habitat in native range				
Jatropha gossypiifolia		+	Ecology - weed origin	Centre of origin well understood, although there is some uncertainty of extent of in native range into South America (vs human-mediated dispersal),	+	Climate	Similar climate in native range to Australia. Occurs across diverse climates in Australia.				
Jatropha gossypiifolia		+	Ecology - knowledge of weed	Well understood ecology, at least in introduced range (little in native range)		Parasitism/predation	No information.				

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Jatropha gossypiifolia		-	Relatedness to non-targets in Australia	No native relatives, but J. curcas is prospective biofuel (although it is approved as a target for BC, and there is no current government support for its develoment as a biofuel)		Others	Genetic diversity in Australia (colour forms, sub species, genetic studies, all conflicting), limited the rust strains that can be used (1 in 4 tested does equally across all, other 3 have differential performance on tested strains). There is no evidence of differential performance for insects (tested on 3 different "leaf forms/colours").				
Jatropha gossypiifolia		+	Knowledge of natural enemies	Comprehensive knowledge of natural enemies across native range, the culmination of 10 yrs of work. The exception is part of South America, but it may not be native there							
Jatropha gossypiifolia		-	Richness & HS of potential agents	Diverse natural enemies, but suprisingly few host-specific organisms. No more known host-specific agents. Congeners not searched yet, nor has J. gossipiifolia in its introduced range							
Jatropha gossypiifolia			Other factors	Rust pathogen risk assessment not yet completed. It does damage P. curcas (but this is unlikely to be a problem) and at least one native species of which congenors have not yet been tested							
Jatropha gossypiifolia	*Jatropha gossypiifolia*	Low	SUMMARY	Host-testing of rust still to be completed. Otherwise, there are no known potential agents despite comprehensive surveying. Long shot opportunities on congeners and likely introduced range of this weed in South America.	Mod	SUMMARY	Rusts have a track record of being highly effective, although it will have to perform well across diverse climates and genotypes. Likelihood becomes low in the absence of knowledge about further agents.	Low-Mod	Rust offers best opportunity, although it may not be sufficiently host-specific. Further potential agents unlikely, and it remains a moderately challenging biocontrol basis	1. Complete host-specificity testing of rust, and release if safe. 2. Targeted exploration of congeners outside of the weed native range in South America.	Consider re-releasing the jewel bug with a broader genetic base to improve impact. The initial introduction was based on one importation that was bred in the laboratory for several years prior to release. Explore whether natural dieback phenomenon can be exploited.
Lantana camara		+	Socioeconomic value	None	-	Weed life cycle	Perennial but seasonal plant. Can defoliate in dry winter months.				
Lantana camara		+	Nomination as target for BC	Approved	-	Type, severity, duration damage	Severe damage needed, and unlikely to be achieved by leaf-feeders (unless they maintain high densities for sustained periods) or seed/flower feeders. Stem-borers couldn't be found, root-feeders needed but hard to find if they do exist, and few potential pathogens have been located.				
Lantana camara		+	Investment opportunities	Also a serious environmental weed. WONS.	-	Synchronicity	Plant quality varies considerably throughout the year, with seasons and soil moisture. Most existing agents appear sensitive to plant quality, and therefore fail to maintain high levels throughout the year.				

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Lantana camara		+	Logistical - native range	Native range of huge area of Americas is accessible	-	Sensitiveness to damage	Tough species, resistant to high levels of repeated defoliation and considerable seed loss. Agents will need to damage >95% of seeds and juveniles simultaneously (see Broughton and Segun)				
Lantana camara		+	Logistical - R&D infrastructure & collaborative links	Infrastructure and links OK	-	Habitat	Agents have been habitat and climatically specific (such as to shady or sunny conditions)				
Lantana camara		-	Ecology - weed origin	Weed origin still not totally resolved. Likely to be a hybrid swarm in the native range. Authoritative genetic study remains unpublished.	-	Climate	Difficult target given that all of c 30 insects released so far have failed to maintain high densities throughout the year, often for climatic reasons, and most are adapted to specific climates within eastern Australia.				
Lantana camara		-	Ecology - knowledge of weed	Well understood in introduced range.	-	Parasitism/predation	Many of insects released so far are susceptible to parasitoids, which may be responsible for observed populations crashes of some of the most effective agents within a few years of their release.				
Lantana camara		+	Relatedness to non-targets in Australia	A few Verbenaceae (2-3) in Australia. Quite a few cultivated varieties	-	Others	Many existing agents do not perform equally well across all Australian phenotypes, at least under laboratory condtions				
Lantana camara		+	Knowledge of natural enemies	Widely throughout much of the Americas for many decades, but comprehensive "gap-analysis" of survey effort is missing. Genetic studies may justify further exploration in the Carribean.			Finding things that will do well across our genotypes has been problematic				
Lantana camara		+	Richness & HS of potential agents	Natural enemies are diverse, including many that are sufficiently host-specific. Many (32?) have already been released. Futher potentially host-specific natural enemies have not been released in Australia, including a few insects under study in South Africa.							
Lantana camara			Other factors								
Lantana camara	*Lantana camara*	High	SUMMARY	Additional host-specific agents already being studied in South Africa. Further potential agents could potentially be found through targeted searching based on modern taxonomy and an analysis of past survey effort.	Low	SUMMARY	Precedence (in Australia and elsewhere) suggests that lantana is a very challenging target, and that the types of agents that are most likely to regulate populations are few.	Mod	Further host-specific agents are likely to be found, but lantana in Australia will likely remain a challenging biocontrol target.	1. Conduct comprehensive gap analysis of historical native-range surveying in the light of recent genetic studies, and evaluate the potential for locating potentially damaging agents. 2. Consider further survey work, based on the gap analysis, specifically focussed on potential agents that are most likely to result in biocontrol goals being met.	Could potentially revisit the c 13 species that failed to establish. However, their potential to cause the required impact would need to be assessed and host-specificity confirmed for some species. Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.
Lantana montevidensis		+	Socioeconomic value	None	-	Weed life cycle	Perennial, but seasonally leafless and without fruits				

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Lantana montevidensis		N	Nomination as target for BC	Approved, agents released in 1990s.	-	Type, severity, duration damage	Introduced agents will need to be drought adapted or at least survive periods when plant is not in leaf or fruit. Stem borers or gallers might be appropriate. Damage will need to be chronic as plants are likely to recover from defoliation.				
Lantana montevidensis		N	Investment opportunities	Also an environmental weed, albeit relatively minor.	-	Synchronicity	Leaf or flower feeding insects will need to synchronise with when the plant is in leaf or flower and be dormant at other times.				
Lantana montevidensis		N	Logistical - native range	Access possible with permits and links to local agencies. Export permits could be difficult depending on exact extent of native range	-	Sensitiveness to damage	Weed can survive periods of drought and remain leaf-less for long periods. Damage will need to be sustained and attack other parts of the plant				
Lantana montevidensis		N	Logistical - R&D infrastructure & collaborative links	Good infrastructure. Links in Brazil would need to be developed.	-	Habitat	The weed is mainly a problem of grazing lands but is also found on rocky outcrops or on poor soils, and wastelands				
Lantana montevidensis		+	Ecology - weed origin	Well understood, from S Brazil, Uruguay and Argentina	-	Climate	Agents will need to be able to withstand long periods of drought, which may be more extreme than the native range				
Lantana montevidensis		-	Ecology - knowledge of weed	Does not have the same taxonomic uncertainty as *L.camara, a g* ood species, not hybrid. But ecological knowledge poor	-	Parasitism/predation	Lantana camara insects are susceptible to parasitoids, which may also move to L. montevidensis insects.				
Lantana montevidensis		+	Relatedness to non-targets in Australia	There are 10 genera in the Verbenaceae in Australia. Most are exotic with 1-2 species where its status is uncertain. There are a few cultivated varieties of L. montevidensis, all of which are sterile.		Others					
Lantana montevidensis		-	Knowledge of natural enemies	Limited. Early surveys were conducted but probably on the wrong plant, L.fucata. Most natural enemies were probably collected from L. fucata following mis-identification of host. Two agents released but did not establish as probably from L. fucata, with L. montevidensis being a poor host. Three L. camara agents damage L. montevidensis. More recent surveys were conducted on L. montevidensis and a few potential candidates were identified.							
Lantana montevidensis		-	Richness & HS of potential agents	Thorough surveys on the correct host are needed. Experience on L. camara suggests sufficiently host-specific agents should be relatively easily found.							
Lantana montevidensis			Other factors								

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Lantana montevidensis	*Lantana montevidensis*	High	SUMMARY	Relatively poorly surveyed, but would expect to find a diverse fauna, including potentially host-specific species.	Low	SUMMARY	Low based on precedence from Lantana camara, but this species does not have hybrid problems that L. camara has. Very high degree of uncertainty due to lack of knowledge. However, agents would need to be able to cope with long drought conditions.	Mod	A poorly understood species. No apparent barriers to finding host-specific agents, but experiences from L. camara suggest that it could be a challenging target.	1. Need to know a lot more about the target before commencing a serious biocontrol effort.	Could revisit past efforts. Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.
Lycium ferocissimum		N	Socioeconomic value	None, but known to harbour native animals such as penguins and mutton birds, as well as the endangered orange belly parrots in Vic and SA (they use it to escape predators). Commitment to restoration following successful biocontrol would be required.	+	Weed life cycle	Perennial thorny shrub. Large seed bank potentially, but not many seedlings seen in infestations. Flowers generally in spring and early summer, although it can also occur at other times of the year if conditions are right.				
Lycium ferocissimum		N	Nomination as target for BC	No, but a biocontrol feasibility study is current being undertaken and the information gathered could feed into the documentation required for nomination.	-	Type, severity, duration damage	Extensive defoliation over several years or a stem/root borer would be required to prevent it from forming extensive, dense infestations. Galling agents that attack flowers could be effective in reducing seed set and hence spread (has been successfully deployed for *Acacia* spp. in South Africa).				
Lycium ferocissimum		+	Investment opportunities	Also an environmental weed and a WoNS.	+	Synchronicity	Plant growing all year round so would be continuously available to agents.				
Lycium ferocissimum		+	Logistical - native range	Southern Africa. No problem with access, especially South Africa. No problem with exporting natural enemies	-	Sensitiveness to damage	Unknown.				
Lycium ferocissimum		+	Logistical - R&D infrastructure & collaborative links	Long-established collaborative links with world-leading government agency and universities that work on biocontrol of weeds	N	Habitat	Well drained soils of any types, but establishes best on lighter soils (e.g. along dry creek beds).				
Lycium ferocissimum		N	Ecology - weed origin	Southern Africa. No doubt about origin. May need to perform genetic study to pin point more precise origin to streamline exploration for candidate agents.	+	Climate	Arid to semi-arid regions of temperate Australia. Mediterranean coastal and island climates in Australia. Similar to that of the native range in South Africa.				
Lycium ferocissimum		-	Ecology - knowledge of weed	No literature available on its biology, although there are some papers on its impact in South Australia. Its genetic structure in Australia is unknown.		Parasitism/predation					
Lycium ferocissimum		-	Relatedness to non-targets in Australia	*Lycium* is a worldwide genus in the Solanaceae family. There is only one native *Lycium* sp. in Australia, *Lycium australe* that grows across southern mainland Australia. It is in the same clade as African boxthorn in the phylogeny. Because of this, a highly-specific pathogen is most likely to be the only option for biocontrol.		Others					

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Lycium ferocissimum		-	Knowledge of natural enemies	Has not been surveyed, but is known to be host of the rust *Puccinia rapipes* in South Africa. Not much literature on natural enemies							
Lycium ferocissimum		-	Richness & HS of potential agents	Being a shrub it is expected to have large fauna. There are several *Lycium* spp. in South Africa so there may be many possible insect natural enemy options, although the need for high host-specificity will be the							
Lycium ferocissimum			Other factors								
Lycium ferocissimum	*Lycium ferocissimum*	Mod	SUMMARY	Limited knowledge of natural enemies in native range as no surveys have been performed, although fauna expected to be large. There are records of the rust Puccinia rapipes infecting the weed in the native range. Good prospect to find a rust strain that would not pose a threat to the Australian native Lycium australe. It is unknown if Insect natural enemies would have the required specificity.	Mod	SUMMARY	A hardy target, but reasons to believe that agents could be found that will help meet biocontrol goals. Would require extensive defoliation over several years to reduce density and biomass of infestations.	Mod	Hardy target that would require extensive defoliation over several years to reduce density and biomass of infestations. Good prospect of finding host-specific agents (e.g. rust) that will be damaging.	1. Nominate as a biocontrol target. 2. Perform an initial survey, especially to find the rust pathogen so that testing on Australian accessions of the weed can be performed to determine if there are any genotype matching issues. 3. Perform preliminary tests on the native Lycium australe to obtain a key indication of host-specificity before embarking on a comprehensive host-specificity testing program.	n/a
Marrubium vulgare		+	Socioeconomic value	None.	+	Weed life cycle	Perennial forb.				
Marrubium vulgare		+	Nomination as target for BC	Yes.	+	Type, severity, duration damage	The damage caused by the released agents, the foliage-feeding plum moth and the root-feeding clearwing moth, in region with suitable climate is potentially high enough to have a significant impact on populations.				
Marrubium vulgare		+	Investment opportunities	Also an environmental weed.	+	Synchronicity	The two released agents are synchronised with the weed life-cycle in Australia.				
Marrubium vulgare		+	Logistical - native range	No impediment with access, especially in Europe.	+	Sensitiveness to damage	Plant mortality has been recorded in the field as a result of clearwing moth damage.				
Marrubium vulgare		+	Logistical - R&D infrastructure & collaborative links	Long-term research was comprehensively carried out with good collaborations in Europe.	N	Habitat	Occurs in alkaline soils in open bushland and grassland, which may not be restrictive for agents.				
Marrubium vulgare		+	Ecology - weed origin	Native to Europe, the middle east and the Mediterranean region including North Africa.	-	Climate	Occurs in both arid and high rainfall zones - this wide range of climate is restrictive to current agents (e.g. clearwing moth may not established in Tasmania due to low summer temperatures.				
Marrubium vulgare		-	Ecology - knowledge of weed	Not comprehensive. Only some studies conducted on its ecology in southern France and Spain.	N	Parasitism/predation	Unknown.				
Marrubium vulgare		+	Relatedness to non-targets in Australia	Belongs to the family Lamiaceae. No Australia native species or crop species closely related to the weed.	-	Others	Current released agents appear restricted to areas with Mediterranean climate.				

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Marrubium vulgare		+	Knowledge of natural enemies	Good knowledge based on the several surveys for arthropods carried out in southern Europe and Morocco in the 1990s. Five potential candidate insect agents were identified, but only two were host-specificity tested and released in Australia (research on the other three was not undertaken because of problems with establishing colonies. Search for potential pathogen agents has never been undertaken.							
Marrubium vulgare		-	Richness & HS of potential agents	Rich insect fauna associated with weed. Host-range of three of the insects identified as having potential for biocontrol has not been investigated.							
Marrubium vulgare			Other factors								
Marrubium vulgare	*Marrubium vulgare*	High	SUMMARY	Comprehensive surveying for arthropod natural enemies across native range completed. Three insect species (Cerambycid, Nitidulid and Butterfly) with potential for biocontrol have already been identified and have good chances of being host-specific (considering there are no closely-related native and economic species to M. vulgare in Australia), but difficulties were encountered in the past to establish colonies of these species. There may be potential pathogen agents in the native range that have been overlooked during arthropod surveys, although highly damaging and widespread pathogens on the weed would more than likely have been noticed during these surveys if present.	Mod	SUMMARY	Field observations made on the first two agents released, indicate that the weed is sensitive to herbivory and can be severely impacted on if climatic conditions are suitable. Prospect to enhance biocontrol efficacy with new agents are promising, especially if they are active in areas where current agents are not.	Mod-High	Good prospect that already identified potential insect agents will be host-specific. Difficult to predict though that they will be damaging in areas where existing agents are not performing well.	1. Recollect and attempt again to establish colonies of the three potential agents identified during surveys so that host-specificity tests can be performed. 2. If insect agents proved too difficult to rear, consider undertaking additional surveys specifically for pathogens.	Distribute clearwing moth agent, which is very slow to spread naturally, into non-contiguous areas where it is not present. Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.
Mimosa pigra		+	Socioeconomic value	None	-	Weed life cycle	A hardy, woody perennial.				
Mimosa pigra		+	Nomination as target for BC	Yes	-	Type, severity, duration damage	Two stem borers are currently the most effective agents (of ?14 released). High levels of prolonged damage expected to be required to cause the required impacts.				
Mimosa pigra		+	Investment opportunities	Also a serious environmental weed. WONS.	-	Synchronicity	Short flowering and fruiting periods presents challenges to perennial flower/seed feeders.				
Mimosa pigra		+	Logistical - native range	American tropics, accessible	-	Sensitiveness to damage	Relatively insensitive to high levels of repeated damage. Readily regrows from the base.				
Mimosa pigra		+	Logistical - R&D infrastructure & collaborative links	Good links and infrastructure	+	Habitat	Natural enemies must be adapted to habitat that is inundated for up to several months a year.				

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Mimosa pigra		+	Ecology - weed origin	Well defined	+	Climate	Similar climate in native range but more extreme dry season in Australia.				
Mimosa pigra		+	Ecology - knowledge of weed	Well understood ecology.	-	Parasitism/predation	Expect parasites of closely related species to switch to agents. [what has happened so far?]				
Mimosa pigra		N	Relatedness to non-targets in Australia	No species in the same tribe, but many species in the same tribe. This includes Neptunia species that are often attacked in host-specificity testing		Others					
Mimosa pigra		+	Knowledge of natural enemies	Comprehensively surveyed across native-range. Further potential agents not expected.							
Mimosa pigra		-	Richness & HS of potential agents	Diverse fauna and many host-specialists. How all known potential agents have now been assessed							
Mimosa pigra			Other factors								
Mimosa pigra	*Mimosa pigra*	Low	SUMMARY	Comprehensively surveyed across native-range. Further potential agents not expected.	Low	SUMMARY	It is a relatively tough biocontrol target and environment. Low in the absence of knowledge about further potential agents.	Low	It is a relatively challenging biocontrol target. Furthermore, additional host-specific agents are unlikely to be found.	No actions identified.	Continue redistributing Nesaecrepida infuscata which is now established. Assess the large amounts of unpublished, semi-analysed post-release data to determine whether impacts of existing agents could be enhanced. Non-classical biocontrol: explore whether natural dieback phenomenon can be exploited. Determine whether there is any value in reintroducing agents that failed to either establish or thrive. Explore whether natural dieback phenomenon can be exploited.
Moraea flaccida and *M. miniata*		+	Socioeconomic value	None.	-	Weed life cycle	Both species produce shoots during winter, flower in early spring and senesce in late spring. One-leaf Cape tulip produces seeds and corms, while two-leaf Cape tulip only reproduces by corms and cormils.				
Moraea flaccida and *M. miniata*		+	Nomination as target for BC	Yes.	N	Type, severity, duration damage	Ideally we need an agent that affect corms, but this would be a major challenge (one insect species found in native range but its suspected annual life-cycle makes it difficult to investigate). Because of corms and ability to regrow, we would need a major defoliator. In South Africa, plants severely affected by the rust did not flower. Because of the associated pasture competition, it is possible that just some reduction in growth of Cape tulips could make a big difference.				
Moraea flaccida and *M. miniata*		+	Investment opportunities	*M. flaccida* is also an environmental weed, while *M. miniata* is primarily a problem for grazing	-	Synchronicity	Agents would need to be well synchronized and capable of surviving in the absence of hosts.				

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Moraea flaccida and *M. miniata*		+	Logistical - native range	Southern Africa. No problem with access, especially South Africa. No problem with exporting natural enemies.	+	Sensitiveness to damage	Experimental data on effect of artificial defoliation indicate that relatively high defoliation is required to prevent reshooting from corms in a non-competition situation. If competition is added we expect that lower levels of defoliation will be effective at controlling the weed.				
Moraea flaccida and *M. miniata*		+	Logistical - R&D infrastructure & collaborative links	Long-established collaborative links with world-leading government agency and universities that work on biocontrol of weeds	N	Habitat	Wide range of soil types from sands to heavy winter waterlogged clays, in permanent annual pastures and bushland.				
Moraea flaccida and *M. miniata*		+	Ecology - weed origin	Southern Africa. No doubt about origin. Genetic study being finalised that will hopefully provide data to pin point the precise origin of these weeds in South Africa	+	Climate	Mediterranean. Grows in winter so this is a plus if a pathogen agent is used because of availability of moisture.				
Moraea flaccida and *M. miniata*		+	Ecology - knowledge of weed	Good knowledge of the biology of the species and how best to control it with traditional method (corms dormancy represents a major challenge)		Parasitism/predation					
Moraea flaccida and *M. miniata*		+	Relatedness to non-targets in Australia	Belong to the family Iridaceae, which contains many ornamental species. There are no Australian native species in the tribe Irideae to which *Moraea* species belong.		Others					
Moraea flaccida and *M. miniata*		+	Knowledge of natural enemies	Limited literature, but surveyed in a few occasions in South Africa. The rust fungus *Puccinia moraeae* was identified as the best candidate. Corm- and seed-feeding weevils were found but not investigated further because of difficulties due to their suspected annual life-cycles.							
Moraea flaccida and *M. miniata*		-	Richness & HS of potential agents	Few natural enemies observed in native range. Rust fungus not expected to infect any other species that *Moraea* , because initial research has revealed that the rust most likely comprises different genotypes that are adapted to different genotypes of Cape tulips.							
Moraea flaccida and *M. miniata*			Other factors								

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Moraea flaccida and *M. miniata*	*Moraea flaccida* and *M. miniata*	Mod	SUMMARY	Rust fungus identified in previous surveys as most promising biocontrol agent. However, because of the extreme specificity of the rust, several strains may be required to attack all putative genotypes of Cape tulips present in Australia.	Mod	SUMMARY	Rust fungus is the most likely organism to be developed for biocontrol - severe infections have been seen in some instances in South Africa. Conditions during winter when plants grow are conducive to development of rust epidemics. High defoliation of plants is required to prevent reshooting from corms, although lower levels may be adequate when pasture competition is considered.	Mod-High	Prospect of biocontrol with the rust fungus is promising. However, more than one strains of the rust are likely to be required to attack the range of genotypes found in Australia.	1. Finalise identification of Australian genotypes and use these to source virulent rust strains for subsequent host-specificity testing.	n/a
Nassella neesiana		+	Socioeconomic value	None.	-	Weed life cycle	Perennial grass. Prolific seeder.				
Nassella neesiana		+	Nomination as target for BC	Yes.	-	Type, severity, duration damage	Agent that affect the grass crown would cause the ideal damage, but specificity of such an agent, even for a pathogen, is most unlikely. Very high and recurrent defoliation would be required as the plant can sustain heavy grazing.				
Nassella neesiana		+	Investment opportunities	Also an environmental weed and a WoNS.	-	Synchronicity	Populations of *U. pencanus* fluctuate a lot in country of origin.				
Nassella neesiana		-	Logistical - native range	Exploration in South America faces logistical problems and also the prospect of not being able to export candidate agents.	N	Sensitiveness to damage	Honours study has shows that defoliation by *U. pencanus* reduces seed production of *N. neesiana* . Rust also seen killing foliage, especially following hot dry conditions				
Nassella neesiana		+	Logistical - R&D infrastructure & collaborative links	Some collaborative links already in place in South America (e.g Argentina).		Habitat	Primarily pastoral habitats. Well adapted to dry conditions.				
Nassella neesiana		+	Ecology - weed origin	South America: Argentina, Uruguay and Chile.		Climate	Climate of Argentina very close to that of Victoria where the weed is a major problem.				
Nassella neesiana		+	Ecology - knowledge of weed	Some knowledge of ecology, but no genetic study performed yet.		Parasitism/predation	A mycoparasite was found covering pustules on some of the plants inoculated with *U. pencanus* during the early stages of the mass rearing process. This is common for rust fungi and it doesn't appear to affect them in the field.				
Nassella neesiana		-	Relatedness to non-targets in Australia	No native *Nassella* species in Australia. It is however, closely-related to Australian stipoid grass species (*Austrostipa* ; 60 species).		Others					
Nassella neesiana		+	Knowledge of natural enemies	Several surveys for pathogens performed in Argentina, but not in neighbouring countries. Pathogens found include three rusts and a smut. Arthropods not surveyed because it is very unlikely that any would have the required host specificity							

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Nassella neesiana			Richness & HS of potential agents	Limited number of pathogens found. The rust *Uromyces pencanus* has been investigated and found to infect and develop pustules on two Australian native *Austrostipa* spp. The incidence of the smut in the field was overall low and quite variable. Extremely low rates of infection were obtained under experimental conditions and thus proper host-specificity testing could not be performed. A culture of the rust *Puccinia graminella* could not be established for biology and specificity studies. Some initial work conducted on the rust *Puccinia nassellae* (ex. *N. neesiana*), but an isolate capable of infecting most of Australian accessions of *N. neesiana* has not been found.							
Nassella neesiana			Other factors								
Nassella neesiana	*Nassella neesiana*	Mod	SUMMARY	All possible candidate pathogen agents have probably be found considering the surveying efforts, albeit not across the entire range, over many years. There are still opportunities to identify host-specific strains in the two rust fungi that have not been fully investigated.	Low	SUMMARY	Grass expected to be resilient to defoliation by natural enemies. Severe infection by one or more pathogen agents over several years would be required to reduce density and biomass of infestations and seed outputs.	Low-Mod	There is some prospect that host-specific and damaging strains of the two candidate rust fungi, which have not been thoroughly investigated, could be found.	1. Consider comments received on application for release of Uromyces pencanus in Australia and undertake additional tests if necessary to support risk analysis (could wait to see how the rust establishes and spreads in New Zealand, where it has been approved for release, before investing in additional tests). 2. Re-assess previous research and decide if additional efforts are warranted to further explore Puccinia nassellae and Puccinia graminella for Chilean needle grass biocontrol in Australia.	n/a
Nassella trichotoma		+	Socioeconomic value	None.	-	Weed life cycle	Perennial grass. Prolific seeder.				
Nassella trichotoma		+	Nomination as target for BC	Yes.	-	Type, severity, duration damage	Agent that affect the grass crown would cause the ideal damage, but specificity of such an agent, even for a pathogen, is most unlikely. Very high and recurrent defoliation would be required as the plant can sustain heavy grazing.				
Nassella trichotoma		+	Investment opportunities	A WoNS.	-	Synchronicity	Rust infection in the field highly variable depending on environmental conditions.				
Nassella trichotoma		-	Logistical - native range	Exploration in South America would face logistical problems and also the prospect of not being able to export candidate agents.	N	Sensitiveness to damage	There are field observations of plants in shady locations that were killed following severe infection by the rust. It is unknown if lower levels of infection would have an impact on the weed populations.				

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Nassella trichotoma		+	Logistical - R&D infrastructure & collaborative links	Some collaborative links already in place in South America (e.g. Argentina).	-	Habitat	Primarily pastoral habitats. Well adapted to dry conditions.				
Nassella trichotoma		+	Ecology - weed origin	South America: Argentina, Uruguay, Chile and Peru.	+	Climate	Climate of Argentina very close to that of Victoria where the weed is a major problem.				
Nassella trichotoma		+	Ecology - knowledge of weed	Good knowledge of ecology and some knowledge of its genetic. PhD study showed that biotypes from NSW were similar to those of Tas but different to those present in Vic.	N	Parasitism/predation	Parasite of the rust identified in native range, but this is common for rust fungi and it doesn't appear to affect them in the field.				
Nassella trichotoma		-	Relatedness to non-targets in Australia	No native *Nassella* species in Australia. It is however, closely-related to Australian stipoid grass species (*Austrostipa* ; 60 species).		Others					
Nassella trichotoma		+	Knowledge of natural enemies	Several surveys for pathogens performed in Argentina, but not in neighbouring countries. Pathogens found include a rust, smut and soil pathogen (Corticiaceae family). Arthropods not surveyed because it is very unlikely that any would have the required host-specificity.							
Nassella trichotoma		-	Richness & HS of potential agents	Limited number of pathogens found. The rust *Puccinia nassellae (ex N. trichotoma)* has been investigated and found to infect and develop pustules on the Australian native *Austrostipa aristoglumis* . The incidence of the smut in the field was overall low and quite variable. Extremely low rates of infection were obtained under experimental conditions and thus proper host-specificity testing could not be performed. Biology and specificity of the soil pathogen could not be resolved.							
Nassella trichotoma			Other factors								
Nassella trichotoma	*Nassella trichotoma*	Low	SUMMARY	Prospects of finding additional candidate pathogen agents that are host-specific are limited, considering that the areas where the weed is most common in Argentina have been surveyed several times over many years.	Low	SUMMARY	Grass expected to be resilient to defoliation by natural enemies. Severe infection by one or more pathogen agents over several years would be required to reduce density and biomass of infestations and seed outputs.	Low	Considering past efforts, there is a low prospect that host-specific and highly damaging strains of the candidate pathogen agents identified could be found.	No actions identified considering the major efforts of the last 10 years to find a classical biocontrol solution for this target.	Investigate soil pathogens suspected to regulate serrated tussock populations in Australia. These may be amenable to an augmentative biocontrol approach.
Onopordum spp.		+	Socioeconomic value	None.	+	Weed life cycle	Nearly all perennial.				
Onopordum spp.		+	Nomination as target for BC	Yes.	N	Type, severity, duration damage	High seed reductions required so success comes from reducing plant size prior to flowering. Significant seed reduction also achieved. Impacts however, have not been monitored.				

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Onopordum spp.		-	Investment opportunities	Mainly a weed of grazing.	+	Synchronicity	No issue.				
Onopordum spp.		+	Logistical - native range	No impediment to access.	+	Sensitiveness to damage	Plants are very susceptible to early damage.				
Onopordum spp.		+	Logistical - R&D infrastructure & collaborative links	Long-term research was comprehensively carried out with good collaborations in Europe.	-	Habitat	Restricted to high rainfall zone fertile pastures, which are currently being turn more and more to grain production where these weeds will be less of a problem.				
Onopordum spp.		+	Ecology - weed origin	Clearly understood as European.	-	Climate	More prevalent in wet years, especially in fertile pastures.				
Onopordum spp.		+	Ecology - knowledge of weed	Ecology of the weed well-understood as a result of research as part of the biocontrol program.	+	Parasitism/predation	None				
Onopordum spp.		-	Relatedness to non-targets in Australia	Globe artichoke and only two Australian native species in the tribe Cardueae.		Others					
Onopordum spp.		+	Knowledge of natural enemies	Good following multi-year surveys in native range.							
Onopordum spp.		+	Richness & HS of potential agents	Multiple agents specific enough. All specific agents identified were released, although may be pathogens in flower heads not fully explored (but long shot).							
Onopordum spp.		-	Other factors	Better role of IWM? Local effectiveness could possibly be improved through agent redistribution or IWM.							
Onopordum spp.	*Onopordum* spp.	Low	SUMMARY	No new agents expected to be found in the native range that could enhance existing biocontrol.	Low	SUMMARY	Biocontrol program established many years ago and believed to be having an impact on stemmed *Onopordum* spp. but never quantified.	Low	Biocontrol program established many years ago and believed to be having an impact but never quantified. No new agents expected to be found in the native range that could enhance existing biocontrol.	No actions identified.	Determine compatibility of released strains of the crown weevil Trichosirocalus brieseii towards stemless Onopordum (O. acaulon) in SA and WA, and if compatible redistribute on this species. Evaluate/quantify the impact of agents released (including those on O. acaulon), assess if impact can be enhanced through IWM and develop recommendations for farmers.
Opuntia & *Cylindropuntia* spp.		N	Socioeconomic value	O.ficus-indica & dragon fruit only potential conflicts. Hasn't historically been a problem owing to high host-specificity of many cactus agents.	+	Weed life cycle	Mostly vegetative propagation resulting in continuous infestations. Sexual reproduction is uncommon in may species, resulting in a small seed bank.				
Opuntia & *Cylindropuntia* spp.		+	Nomination as target for BC	Approved targets are Cylindropuntia imbricata, Cylindropuntia rosea, Opuntia aurantiaca, Opuntia dillenii, Opuntia monoacantha, Opuntia streptacantha, Opuntia stricta, Opuntia tomentosea, Opuntia	+	Type, severity, duration damage	No information.				
Opuntia & *Cylindropuntia* spp.		+	Investment opportunities	Also potentially serious environmental weeds. WONS (except O.ficus -indica).	+	Synchronicity	Cladodes are continually available. Fruits are seasonal.				
Opuntia & *Cylindropuntia* spp.		+	Logistical - native range	Easy access to native range. Surmountable permit difficulties in Argentina	+	Sensitiveness to damage	Past success indicate plants can be relatively sensitive. Plants are susceptible to secondary infection, amplifying the impact of biocontrol agents				

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Opuntia & *Cylindropuntia* spp.		+	Logistical - R&D infrastructure & collaborative links	Excellent in centres of origin in USA, Mexico and Argentina.	N	Habitat	No information.				
Opuntia & *Cylindropuntia* spp.		N	Ecology - weed origin	Moderately well understood and delimited. Taxonomy of all invasive species not fully resolved, and therefore nor is their native range. Widespread so good opportunities for exploration.	-	Climate	Together species occur across a wide range of climates which may pose challenges for biocontrol. Individually agents can have very restricted distributiouns.				
Opuntia & *Cylindropuntia* spp.		-	Ecology - knowledge of weed	Recent steady progress on identification of species in Australia. However, little information available on invasions and ecology	N	Parasitism/predation	Existing cochineal insects, although effective, are subject to existing predators and parasites and so future species may also be.				
Opuntia & *Cylindropuntia* spp.		+	Relatedness to non-targets in Australia	No native cacti in Australia. O.ficus-indica & dragon fruit only potential conflicts, but host specificity of agents will allow determination of risk.	+	Others	Australian infestations are remote and isolated which may pose challenges for establishing agents, especially for movement of agents between host populations.				
Opuntia & *Cylindropuntia* spp.		N	Knowledge of natural enemies	Early surveys were compreehensive on a few species, but a re-appraisal needed							
Opuntia & *Cylindropuntia* spp.		+	Richness & HS of potential agents	All evidence (e.g. work done in North America as a result of Cactoblastis invasion; extensive work by South Africans) suggests a diverse range of species-specific natural enemies. Taxa with host-specific insects includes Cactoblastis and cochineal insects Poor understanding of what cochineals are already in Australia, but it is expected to only include a subset of potential agents.							
Opuntia & *Cylindropuntia* spp.		-	Other factors	The identity of existing biocontrol agents in Australia is uncertain, in part due to changing taxonomy and prevalence of sibling species (and "races"). It is therefore unclear what we already have.							
Opuntia & *Cylindropuntia* spp.	*Opuntia* & *Cylindropuntia* spp.	High	SUMMARY	Further host-specific agents are expected to be relatively easily found for most target species, once their taxonomy has been clarified.	Mod	SUMMARY	Good precedent for effective control, including against some species that have already been targeted in Australia. Great opportunities presented by new knowledge on potential agents. However, breadth of target species and geographic regions do pose challenges.	Mod-High	The main barrier to successful biocontrol is the range of species and geographic regions to be targeted. Nonetheless, there are considerable synergies possible from addressing them simultaneously.	1. Clarify the taxonomy of naturalised species in Australia, and prioritise them for biocontrol. 2. Synthesis and gap-analysis of past work, including identifying biocontrol taxa already present in Australia. 3. Consider assessing the identified races of Cactoblastis and Dactylopius (cochineal insects) against the Australian invasive taxa (in a matrix design) to identify those that will have greatest impact on the highest priority Opuntioid species.	Using genetic analyses determine what Dactylopius species we have in Australia, and their preferred hosts. Any re-releases may require retesting as these species were unintentionally left off the Federal Approved Release List for Biocontrol agents. Evaluate/quantify the impact of selected agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Parkinsonia aculeata		+	Socioeconomic value	None	-	Weed life cycle	Medium-lived perennial. Winter decidious under cool and/or dry conditions. Long-lived seed bank. Most flowering occurs during a short period, the commencement of which can vary by months depending on the climate zone.			Complete UU and U2 release program.	
Parkinsonia aculeata			Nomination as target for BC	Approved.	-	Type, severity, duration damage	Tough target for external defoliators and multi-voltine seed and flower feeders. Defoliators expected to be required to maintain high, sustained densities to cause serious impact. Synergistic (or antagonistic) effects with "dieback" are possible. Photosynthetic bark means it can at least survive without leaves				
Parkinsonia aculeata			Investment opportunities	An environmental weed. WONS.		Synchronicity	Seed-feeders, flower feeders and even leaf feeders need to be tightly synchronised as resources are only avaibale for a short period (e.g. Penthobruchus).				
Parkinsonia aculeata		+	Logistical - native range	Huge native range (USA to Argentina), which includes many countries with good access.	-	Sensitiveness to damage	Not as resilient as mesquite or prickly acacia, but can nonetheless regrow from the base following extensive mechanical damage. Juveniles are hardy, and survive repeated browsing, drought and fire. [check JB result]				
Parkinsonia aculeata		+	Logistical - R&D infrastructure & collaborative links	Native range includes countries with good infrastructure and excellent linkages (Argentina, Mexico, USA).	N	Habitat	May be inundated for months at a time in wetland habitats.				
Parkinsonia aculeata		N	Ecology - weed origin	Weed origin fairly well known, but still unclear how different South American populations are. No evidence that natural enemies perform differentially on it.	-	Climate	Agents need to deal with wet-dry climate, although similar to what is encountered in native range. Climate is highly variable across target regions.				
Parkinsonia aculeata		N	Ecology - knowledge of weed	Very well understood.	-	Parasitism/predation	Bruchids are susceptible to high levels of parasitism. Future exposed feeding geometrics may also be susceptible to predators and parasitoids.				
Parkinsonia aculeata		-	Relatedness to non-targets in Australia	Phylogenetic relationships still disputed, but it is in Peltorphorum group that includes Australian species [how much of an issue for testing so far?]	-	Others	No highly damaging insects known (e.g. systemic pathogens, stem feeders)				
Parkinsonia aculeata		-	Knowledge of natural enemies	Natural enemies comprehensively surveyed. Thorough gap analysis of native-range survey work identified a few areas across the native range where additional survey work is most likely to yield new species.	-						

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Parkinsonia aculeata		-	Richness & HS of potential agents	High species richness but few species are sufficiently host-specific. No further potential agents are known			,				
Parkinsonia aculeata		+	Other factors	1 sp of Geometrid being released, and 1 being approved for release. Both are defoliators.							
Parkinsonia aculeata	*Parkinsonia aculeata*	Low	SUMMARY	Comprehensive surveying across native range completed, and finding further potential agents is considered unlikely after the release of the two existing Geometrid species.	Low	SUMMARY	Lack of apparently damaging agents in the native range. Challenging ecology for a target, especially given lack of apparently damaging agents in the native range, although there is potential for synergies with "dieback", and management goals are not onerous.	Low	A reasonably difficult target with few prospects of finding further host-specific, damaging agents (following release of the 2 geometrid agents).	1. Additional surveying in the few remaining areas identified by native range survey analysis that are most likely to yield additional agents. This includes resolving the taxonomy in South American native range (esp Argentina) to guide searches.	Follow through on national release and redistribution of two existing agents (one approved, the other subject to approval). No further benefits are expected from previously released agents. Non-classical biocontrol: explore whether natural dieback phenomenon can be exploited.
Parthenium hysterophorus		+	Socioeconomic value	None	-	Weed life cycle	Annual weed, can flower within in 4 weeks after rain, large seed bank, fast growing				
Parthenium hysterophorus		+	Nomination as target for BC	Approved.	-	Type, severity, duration damage	??				
Parthenium hysterophorus		+	Investment opportunities	Also an environmental weed and causes allergies. WONS.	+	Synchronicity	Typically good synchronicity with existing agents in good seasons. Inter-year variabilty in host availability expected to create challenges. Agents also need to be synchronised with host recruitment after first summer rains.				
Parthenium hysterophorus		+	Logistical - native range	Large and well defined, American tropics, accessible.	+	Sensitiveness to damage	Existing BC agents have been reported as being responsible for greatly reducing plant height and vigour				
Parthenium hysterophorus		+	Logistical - R&D infrastructure & collaborative links	Good infrastructure and links.	N	Habitat					
Parthenium hysterophorus		+	Ecology - weed origin	Origin is well known.	N	Climate	Native range includes climates that are similar to target regions in Australia. High inter-year variabilty in climate (affecting both host and agent populations) may present challenges. Existing agents typically differ in their climatic requirements, between years and regionally. [dhileep?]				
Parthenium hysterophorus		+	Ecology - knowledge of weed	Ecology is relatively well understood. Two genotypes present in Australia, but there is no evidence that natural enemies distinguish between them.	N	Parasitism/predation	Gall insects susceptible to parasitism.				
Parthenium hysterophorus		N	Relatedness to non-targets in Australia	Sunflower is the closest, but has not significantly limited agent selection.		Others					
Parthenium hysterophorus		+	Knowledge of natural enemies	Native range well surveyed, including North and South America. However, a comprehensive gap-analysis of survey efforts has not been done.							

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Parthenium hysterophorus		-	Richness & HS of potential agents	A diverse fauna, including a relatively diverse range of host-specific insects. However, no further potential agents have been identified							
Parthenium hysterophorus			Other factors								
Parthenium hysterophorus	*Parthenium hysterophorus*	Low	SUMMARY	No real opportunities identified for finding more potential agents.	Low	SUMMARY	Low based on absence of potential agents. Precedence suggests that effective biocontrol is possible, although it remains a relatively difficult target.	Low	Further potential agents are considered unlikely. Furthermore, it remains a relatively difficult target.	No actions identified.	Assess the distribution of the most effective agents and, if required, distribute them into non-contiguous places (southern Qld). Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers.
Phyla canescens		+	Socioeconomic value	None	-	Weed life cycle	Can seed prolifically, and is clonal, with large long-lived root system. Mostly evergreen.				
Phyla canescens		+	Nomination as target for BC	Yes	-	Type, severity, duration damage	Only one potential agent (rust) capable of causing type of damage likely to cause mortality and sufficent reduction in reproduction.				
Phyla canescens		-	Investment opportunities	Also an environmental weed.		Synchronicity					
Phyla canescens		+	Logistical - native range	Good access to native range.	-	Sensitiveness to damage	Able to withstand considerable, prolonged mechanical damage, and can readily re-establish from stem fragments under the right conditions				
Phyla canescens		+	Logistical - R&D infrastructure & collaborative links	Good local infrastructure and links	N	Habitat	Habitat similar to native range. Can flood for weeks at a time, but not typically every year.				
Phyla canescens		+	Ecology - weed origin	Well understood genetically: invasive genotypes are predominantly from central Argentine	N	Climate	Similr to native-range. High inter-year variability in rainfall.				
Phyla canescens		+	Ecology - knowledge of weed	Well understood	N	Parasitism/predation	No information.				
Phyla canescens		-	Relatedness to non-targets in Australia	High host specificity requirement as P. nodiflora is native to Australia.		Others	No evidence of significant herbivory in native range				
Phyla canescens		+	Knowledge of natural enemies	Comprehensive surveying of P. canescens/P. reptans completed with only a few untested, possibly host-specific organisms identified							
Phyla canescens		-	Richness & HS of potential agents	Relatively depauperate fauna, with few common, damaging species. No tested species are sufficiently host-specific. A potentially damaging pathogen on P reptans could not be relocated, and has never been reported off P. canescens.							
Phyla canescens		-	Other factors	Tested insects all cause unacceptable damage to P. nodiflora in laboratory tests.							

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Phyla canescens	*Phyla canescens*	Low	SUMMARY	Few prospects for finding host-specific agents.	Low	SUMMARY	Expected to be a challenging biocontrol target that spreads both clonally and by seed. Only one potentially damaging natural enemy known, and it hasn't been relocated.	Low	Hardy plant that spreads both clonally and by seed, with few prospects of finding agents capable of causing the required damage to survival and reproduction.	1. Locate rust on P. reptans and determine its relative preference for P. canescens. This is likely to require dedicated resources and development of contacts in Bolivia. Rusts have good track records as biocontrol agents.	n/a
Physalis viscosa		+	Socioeconomic value	None, although produces a fruit that is valued for jam making and cooking.	-	Weed life cycle	Summer-growing perennial herb. Extensive and deep perennial roots make it highly competitive. Regenerates from seed or from rhizomatous root material.				
Physalis viscosa		-	Nomination as target for BC	No.	-	Type, severity, duration damage	Severe and continuous defoliation would be required considering the extent of the tap root.				
Physalis viscosa		+	Investment opportunities	Also a cropping weed. Opportunity to combine exploration for natural enemies and initial host-specificity testing with a project on *S. elaeagnifolium* since parts of their native range overlaps and the same non-target species would have to be tested.		Synchronicity	Could be a problem since all aerial parts die in autumn.				
Physalis viscosa		-	Logistical - native range	No logistic issues with exploration in North America. Exploration in South America would face logistical problems and also the prospect of not being able to export candidate agents.	-	Sensitiveness to damage	Has an extensive root system and therefore would have potential to recover from damage if not severe and persistent. A root feeder would be ideal.				
Physalis viscosa			Logistical - R&D infrastructure & collaborative links	R&D infrastructure in the USA very good and high potential to build collaborative links. Some collaborative links also in place in South America.	N	Habitat	Grows mostly on clay and loam soils and prefers open land.				
Physalis viscosa		-	Ecology - weed origin	Wide range; North and South America. Precise region of origin unknown.	N	Climate	Warm temperate regions. Restricted distribution.				
Physalis viscosa		-	Ecology - knowledge of weed	Has been mainly studied within a cropping context.		Parasitism/predation					
Physalis viscosa		-	Relatedness to non-targets in Australia	Belongs to the family Solanaceae. Closely-related to the fruit crop Cape gooseberry (*Physalis peruviana*). There are some Australian native species in the *Physalis* genus (e.g. *P. minima* , *P. angulata*).		Others					
Physalis viscosa		-	Knowledge of natural enemies	No literature of natural enemies specifically recorded from this species and no survey for natural enemies done. A Chrysomelid species (*Lema bilineata*) of South American origin is known to be feeding on it in Australia, but it also feeds on a range of solanaceous species.							
Physalis viscosa		-	Richness & HS of potential agents	Unknown							
Physalis viscosa			Other factors	Attack							

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Physalis viscosa	*Physalis viscosa*	Low	SUMMARY	No known host specialists, although specific searches in the native range have not been made. Feasibility may increase once results from preliminary surveys in native range are obtained.	Mod	SUMMARY	Severe and continuous defoliation on the related weed *Solanum elaeagnifolium* in South Africa has been shown to have a major impact, even though it has an extensive root system like *P. viscosa* . On this basis, it may be possible to find sufficiently damaging agents.	Low-Mod	A challenging biocontrol target because of its closeness to Cape gooseberry and native *Physalis* spp. Prospect may increase once knowledge of natural enemies is obtained.	1. Determine if there are sufficient data to support nomination as a biocontrol target; if so nominate. 2. Perform genetic study to identify more precisely region of origin of Australian populations. 3. Perform an initial survey of insect and fungi natural enemies there.	n/a
Prosopis spp.		+	Socioeconomic value	None.	-	Weed life cycle	Exceedingly hardy plant with large root reserves and effective dormancy strategies, but not such an issue given bc goals (mortality although desirable, may not be necessary to slow spread). Can seed prolifically , especially in favourable years.				
Prosopis spp.		+	Nomination as target for BC	Yes	-	Type, severity, duration damage	Damaging natural enemies found on most parts of the plant. High levels of sustained damage likely to be required to cause impact. This is the case for Evippe sp. #1.				
Prosopis spp.		N	Investment opportunities	WONS	+	Synchronicity	Mostely evergreen. Reproduction typically synchronised, posing challengies for seed/flower feeders.				
Prosopis spp.		+	Logistical - native range	Good access to native range (Americas).	-	Sensitiveness to damage	Can withstand high levels of sustained damage. Difficult to kill.				
Prosopis spp.		+	Logistical - R&D infrastructure & collaborative links	Good local infrastructure and links	neutral	Habitat	Species swarms/hybrids could mean that agents won't work equally well across all infestations, but current indications suggest that won't be a problem				
Prosopis spp.		+	Ecology - weed origin	Algarobious Section to which Australian species and hybrids belong occurs across Americas. Native range of represented species relatively well delimited.	N	Climate	Climate and habitat similar to native range, but areas at most threat relatively diverse (250-600 mm rf/yr; hot to cool winters). Existing agents don't perform equally well across all range, necessitating use of multiple				
Prosopis spp.		+	Ecology - knowledge of weed	Ecology very well understood in Australia and native range.	+	Parasitism/predation	Parasitism rates on leaf-tiers in Australia is suprisingly low.				
Prosopis spp.		+	Relatedness to non-targets in Australia	Few native species in the same tribe in Australia.	+	Others	Good precedence with Evippe that has resulted in very high, sustained reduction in growth and seed production (and therefore spread rates and ability to manage). Other similar agents are available.				

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Prosopis spp.		+	Knowledge of natural enemies	Natural enemies well studied in native range across the native range. However, large parts of native range not yet surveyed, and all plant parts not systematically surveyed (e.g. seedlings, stems, roots), nor have pathogens. "Agronomic" pests of mesquite also studied elsewhere in introduced range.							
Prosopis spp.		+	Richness & HS of potential agents	Very diverse natural enemies (c 1000 species, despite incomplete native-range surveying) that often do equally well across all invaded taxa and hybrids. Host-specific agent already identified, including under study in Sth Africa. Further host-specific insects expected to be found relatively easily.							
Prosopis spp.		+	Other factors								
Prosopis spp.	*Prosopis* spp.	High	SUMMARY	Expect to find diverse range of sufficiently host-specific, culturable organisms relatively easily.	Mod	SUMMARY	A hardy host, but reasons to believe that additional agents could be found that will help meet biocontrol goals.	Mod-High	A hardy host, but reasons to believe that sufficiently host-specific and damaging agents could be found and studied relatively easily.	1. Confirm high feasibility through a gap analysis of previous work and more comprehensive survey. 2. Host testing of potential agents following careful prioritisation based on potential impact, including evaluation of South African work.	No actions identified.
Raphanus raphanistrum		+	Socioeconomic value	None. Only low value for grazing animals.	N	Weed life cycle	Annual or biennial herb.				
Raphanus raphanistrum		-	Nomination as target for BC	No.	-	Type, severity, duration damage	Known for its compensatory growth when damaged and for increased production of anti-herbivore chemicals as a result of herbivory.				
Raphanus raphanistrum		+	Investment opportunities	A main weed of cropping that has developed herbicide resistance.	-	Synchronicity	Annual growth cycle means that oversummering of agents would be required.				
Raphanus raphanistrum		+	Logistical - native range	No impediment with access and exportation of natural enemies from Europe.	-	Sensitiveness to damage	Low sensitivity, will produce seed from small plants.				
Raphanus raphanistrum		+	Logistical - R&D infrastructure & collaborative links	Long-term research was comprehensively carried out with good collaborations in Europe.	N	Habitat	Wide range of agricultural habitats.				
Raphanus raphanistrum		-	Ecology - weed origin	The origin is diffuse within Eurasia. Genetic work would be required to more precisely pin point origin of Australian populations.	-	Climate	Winter-growing, across temperate and Mediterranean climates.				
Raphanus raphanistrum		+	Ecology - knowledge of weed	A major weed of cropping areas that has been well studied.	-	Parasitism/predation	Potential parasites of insect natural enemies already here (because of pests on canola)				
Raphanus raphanistrum		-	Relatedness to non-targets in Australia	Belongs to the family Brassicaceae. Closely related to edible radish, *R. sativus* (indeed may actually be the same species), and in the same family as the important crop, canola.		Others					

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Raphanus raphanistrum		N	Knowledge of natural enemies	Good knowledge. Surveys carried out in southern Europe and North Africa, but may not be the exact regions of origin							
Raphanus raphanistrum		-	Richness & HS of potential agents	Rich range of natural enemies, but most also feed on radish and canola. Agents that only target seeds of *Raphanus* spp. could be acceptable for biocontrol.							
Raphanus raphanistrum			Other factors								
Raphanus raphanistrum	*Raphanus raphanistrum*	Low	SUMMARY	Even if additional areas in native range are surveyed, there is limited prospect of finding host-specific agents as the weed is very closely-related to edible radish. Pathogen agents may be the only option for host-specificity.	Low	SUMMARY	Weed known for its ability to compensate when damaged and thus would require highly damaging agents.	Low	Low prospect of finding host-specific agents that are highly damaging. Very closely related to edible radish.	No actions identified.	Consider developing a non-commercial augmentative biocontrol approach to enhance the efficacy of existing pathogens that affect the weed in Australia, especially *Hyaloperonospora parasitica* , which is genetically distinct to isolates found on Brassica spp. including canola.
Reseda lutea		+	Socioeconomic value	None.	-	Weed life cycle	Biennial or short-lived perennial herb with a woody/deep tap root. Reproduce by seeds.				
Reseda lutea		+	Nomination as target for BC	Yes.	-	Type, severity, duration damage	Has a deep tap root and thus is capable to easily regenerate after defoliation. A root feeder would be ideal. Seed feeders may have potential although there is limited knowledge on seedbank dynamic and longevity.				
Reseda lutea		+	Investment opportunities	Mainly a weed of agriculture, including cropping, it is also an environmental weed.	-	Synchronicity	Unknown.				
Reseda lutea		+	Logistical - native range	Europe. No access difficulties. No problem with exporting natural enemies.	-	Sensitiveness to damage	Sensitive to competition. Capable of regenerating following herbicide burnt off of foliage.				
Reseda lutea		+	Logistical - R&D infrastructure & collaborative links	Australian laboratory in Southern France with necessary R&D infrastructure. A range of collaborative links have been established over the years between Australian and European scientists.	N	Habitat	Calcareous soils. Disturbed habitats.				
Reseda lutea		+	Ecology - weed origin	Mediterranean-Europe.	-	Climate	Mediterranean and temperate climates.				
Reseda lutea		+	Ecology - knowledge of weed	Basic knowledge available from a Master Thesis.		Parasitism/predation					
Reseda lutea		-	Relatedness to non-targets in Australia	Belongs to the family Resedaceae, which is closely-related to the family Cruciferae. No Australia native spp. in the *Reseda* genus and a minor ornamental species		Others					
Reseda lutea		+	Knowledge of natural enemies	Basic. Surveys of insects and fungi conducted in the native in 1994-96.							

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Reseda lutea		-	Richness & HS of potential agents	Not very rich based on surveys. Fungi were ruled out on the basis of low potential impact. Investigations focuses on two of the seven insects collected, that were deemed most promising based on observed damage in the field. Adults of the weevil *Baris picicornis* fed on a few *Brassica* and *Lepidium* spp. and was capable of completing its lifecycle on subspecies of *B. rapa* . A colony of the seed-feeder *Bruchela suturalis* could not be established with the timeframe of the project and was thus not tested.							
Reseda lutea			Other factors								
Reseda lutea	*Reseda lutea*	Low	SUMMARY	Considering previous work, there are few options remaining to identify host-specific agents among the limited number of natural enemies.	Low	SUMMARY	Of all identified natural enemies, only seed-feeders remain as a possibility. They are however, unlikely to provide the necessary control to achieve the goal of biocontrol.	Low	Low prospect of finding host-specific agents that are damaging to the roots, stems and/or foliage of the weed.	No actions identified, beside establishing if it is a weed that is of real concern to grazing industries. It is mainly a weed of cropping and may only be relevant to grazing within the context of grazing-crop rotation.	n/a
Romulea rosea		+	Socioeconomic value	No conflict envisaged, although some parrots are known to eat its seed.	-	Weed life cycle	Perennial herb that produces both corms and seeds. Seed prolifically. Very dense infestations seem in Australia but never in the native range (a possible indication of corm predation by animals or insects in South Africa).				
Romulea rosea		-	Nomination as target for BC	No. No main hurdle envisaged with nominating the weed as a target for biocontrol, although impact data may not be readily available.	N	Type, severity, duration damage	A corm feeder would be ideal but may not exist or be rare. Repeated defoliation over a few years may be sufficient to deplete corms and prevent seeding.				
Romulea rosea		-	Investment opportunities	Mainly a weed of grazing.	-	Synchronicity	Seed and corm germinate or sprout in autumn to winter and grow over winter and flower from August to November. This means that potential agents would need to oversummer for survival every year. Plant growing in winter is an advantage for a pathogen agent as there is more moisture available for epidemic to develop.				
Romulea rosea		+	Logistical - native range	Southern Africa. No problem with access, especially South Africa. No problem with exporting natural enemies.	+	Sensitiveness to damage	Reported to be highly sensitive to defoliation. Cutting to one centimetre above ground at three to five week intervals reduced onion grass corm mass by 70 %.				
Romulea rosea		+	Logistical - R&D infrastructure & collaborative links	Long-established collaborative links with world-leading government agency and universities that work on biocontrol of weeds.	+	Habitat	Wide range of habitats (annual pastures, bushland, urban areas), especially where fertility is low and there is limited competition. Also one of the few species to grow in compacted soils and heavily trafficked areas.				

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Romulea rosea		+	Ecology - weed origin	Southern Africa. No doubt about origin, it is restricted to the Southern Cape Province of South Africa.	+	Climate	Widely distributed throughout temperate and Mediterranean areas of Australia. In its native habitat, mainly in Mediterranean climate areas, also including temperate regions of year-round rainfall (southern Cape region). There is likely to be a good climate match for agents.				
Romulea rosea		N	Ecology - knowledge of weed	Limited. Some work on corm biology, fertiliser response and sensitiveness to mowing has been done. It belongs to the family Iridaceae and therefore is potentially genetically diverse. Its genetic structure in Australia is unknown.		Parasitism/predation					
Romulea rosea		+	Relatedness to non-targets in Australia	South African species in the Iridaceae are not closely related to Australian species within this family. There is no Australian native *Romulea* sp.		Others					
Romulea rosea		-	Knowledge of natural enemies	Has not been surveyed and there is no literature on its natural enemies.							
Romulea rosea		-	Richness & HS of potential agents	Plant expected to have a small associated fauna. A rust fungus *Uromyces gladioli* has been recorded from it in South Africa. This rust is also known from *Gladiolus* , *Babiana* and *Geissorhiza* spp. in South Africa, but it is possible that pathotype specialised on different host genus and/or species exist.							
Romulea rosea			Other factors								
Romulea rosea	*Romulea rosea*	Low	SUMMARY	Natural enemies mostly unknown as the weed has not been surveyed in the native range, but fauna expect to be limited. However, good prospect of finding a host-specific agent since there is no Australian native species in the same genus. A rust fungus is recorded on it in the native range, although it is also known to infect three other species in the Iridaceae, so a pathotype specific to *Romulea* spp. would have to be found.	Mod	SUMMARY	Known to be sensitive to defoliation (it has few leaves), so pending a damaging agent is found that can oversummer when the weed is dormant, biocontrol has good chances of being successful.	Low-Mod	Although has not been surveyed before, there is some prospect of finding host-specific agent(s) that will be impactful since the weed is sensitive to defoliation (because it has few leaves).	1. Determine if there are sufficient data to support nomination as a biocontrol target; if so nominate. 2. Perform an initial survey, especially to find the rust pathogen so that testing on Australian accessions of the weed can be performed to determine if there are any genotype matching issues. 3. Perform preliminary tests on ornamental Gladiolus spp. grown in Australia to obtain a key indication of host-specificity before embarking on a comprehensive host-specificity testing program.	n/a
Rosa rubiginosa		+	Socioeconomic value	No conflict envisaged, although it is used to make rose hips liquor, syrup and jam.	-	Weed life cycle	Hardy perennial shrub. Can germinate at almost any time of the year. Young seedlings are not very competitive				
Rosa rubiginosa		-	Nomination as target for BC	No.	-	Type, severity, duration damage	Stem borer would be ideal to reduce stand density, but the likelihood of being sufficiently specific is very low				

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Rosa rubiginosa		+	Investment opportunities	Also an environmental weed.	N	Synchronicity	Deciduous and sheds its leaves in autumn, with new leaf and cane growth starting in spring. Agents that attack foliage would have to be adapted to this phenology.				
Rosa rubiginosa		+	Logistical - native range	Europe. No access difficulties. No problem with exporting natural enemies. Western Asia could be more problematic and thus Europe should be favoured for exploration	-	Sensitiveness to damage	Unknown.				
Rosa rubiginosa		+	Logistical - R&D infrastructure & collaborative links	Australian laboratory in Southern France with necessary R&D infrastructure. A range of collaborative links have been established over the years between Australian and European scientists	N	Habitat	Infestations often heaviest in hilly and rocky country around trees on creek banks and along fence lines.				
Rosa rubiginosa		N	Ecology - weed origin	Europe and western Asia (Eurasia). Precise region where Australian introductions came from unknown.	N	Climate	Widespread but more common in the cooler, high rainfall areas.				
Rosa rubiginosa		N	Ecology - knowledge of weed	Limited knowledge on biology. Paddocks with dense infestations rarely seen; an indication that it may be more a symptoms of poor management.		Parasitism/predation					
Rosa rubiginosa		-	Relatedness to non-targets in Australia	In the Rosaceae family and thus closely-related to ornamental roses.		Others					
Rosa rubiginosa		+	Knowledge of natural enemies	Surveys were done on it and its closed relatives in the 1960s in Europe, identifying a range of potential insect agents.							
Rosa rubiginosa		-	Richness & HS of potential agents	Being a shrub it is expected to have large fauna. Possibilities of biocontrol was investigated by New Zealand, but all potential agents also affected roses.							
Rosa rubiginosa			Other factors								
Rosa rubiginosa	*Rosa rubiginosa*	Low	SUMMARY	Considering the number of closely-related species, especially in the *Rosa* genus, it is very unlikely that sufficiently host-specific agents could be found, unless pathogens like rust fungi are investigated.	Low	SUMMARY	A hardy host that would likely require a suite of damaging agents to reduce density of infestations.	Low	Low prospect of finding sufficiently host-specific agents because of the weed's close-relationship with ornamental roses. Would likely require a suite of damaging agents to reduce density of infestations.	1. Determine if there are sufficient data to support nomination as a biocontrol target; if so nominate. 2. Conduct survey in native range for pathogens, as they are the most likely options to achieve the level of host-specificity required.	n/a
Rubus fruticosus agg. (primarily *R. anglocandicans*)		N	Socioeconomic value	Conflict was identified when biocontrol was originally proposed in the 1980s, but was resolved (without implementation of the Biological Control Act).	N	Weed life cycle	Perennial shrub with bird-dispersed seed. Facultative apomictic species (mainly clonal but with possibility of crossing)				

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Rubus fruticosus agg. (primarily *R. anglocandicans*)		+	Nomination as target for BC	Yes.	-	Type, severity, duration damage	Based on experience with rust fungus, high defoliation would be required to make a big reduction in density and spread. Affecting crown/roots could have a major impact on spread and stand size/density (remove high and density of canes).				
Rubus fruticosus agg. (primarily *R. anglocandicans*)		+	Investment opportunities	Also an environmental weed and a WoNS. There has been so far no investment by the grazing industry on the biocontrol of this species.	-	Synchronicity	Agent damage needs to begin early in growing season, before onset of flowering.				
Rubus fruticosus agg. (primarily *R. anglocandicans*)		+	Logistical - native range	Easy access to Europe and no impediments to exportation of natural enemies.	-	Sensitiveness to damage	Hardy plant. Extensive and repeated defoliation over many years required to deplete the extensive root system and ability to regrow				
Rubus fruticosus agg. (primarily *R. anglocandicans*)		+	Logistical - R&D infrastructure & collaborative links	Australian laboratory in Southern France with necessary R&D infrastructure. A range of collaborative links have been established over the years between Australian and European scientists	-	Habitat	Wide range of habitats in temperate and high rainfall areas. Associated with watercourses in Mediterranean regions of WA.				
Rubus fruticosus agg. (primarily *R. anglocandicans*)		+	Ecology - weed origin	Eurasia, a wide native range. Australian populations however, most likely to originate from Europe. Indeed, *R. anglocandicans* is believed to have originated from the United Kingdom.	-	Climate	Humid and subhumid temperate climate. Occupies much drier and hotter climate zones in Australia than in the native range. Climate is already a limiting factor for some agents, eg rust, in dryer, hotter areas.				
Rubus fruticosus agg. (primarily *R. anglocandicans*)		+	Ecology - knowledge of weed	Good knowledge on biology but do not know well the best life cycle components to target to reduce spread spatially and temporally. Extensive research has been done on the taxonomy and genetic of invasive *Rubus* spp. in Australia.		Parasitism/predation					
Rubus fruticosus agg. (primarily *R. anglocandicans*)		-	Relatedness to non-targets in Australia	Belongs to the family Rosaceae. Closely-related to commercially grown and native *Rubus* spp. It is also in the same family as ornamental roses.		Others					
Rubus fruticosus agg. (primarily *R. anglocandicans*)			Knowledge of natural enemies	Very good. Several surveys have been done in the native range over the years. Formal surveys however, have never been carried out in the UK, the putative region of origin of *R. anglocandicans* .							

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Rubus fruticosus agg. (primarily *R. anglocandicans*)		-	Richness & HS of potential agents	Potential insect agent candidates found were not sufficiently specific for release. The rust fungus *Phragmidium violaceum* was found to be highly-specific and pursued further for biocontrol in Australia. Indeed, its specificity is so high that more than a single rust strain was required to infect the different species in the R. fruticosus agg. A few additional possible agents have been identified in a recent extensive review of the literature but are potentially also capable of attacking other *Rubus* spp.							
Rubus fruticosus agg. (primarily *R. anglocandicans*)			Other factors								
Rubus fruticosus agg. (primarily *R. anglocandicans*)	*Rubus fruticosus* agg. (primarily *R. anglocandicans*)	Low	SUMMARY	Considering previous extensive work, the possibility of finding new host-specific agents in areas that have not been surveyed in Europe is low.	Low	SUMMARY	Hardy target with limited prospect of finding new agents that would cause extensive defoliation over several years and/or attack crowns to significantly reduce density and biomass of infestations.	Low	Low prospect of finding new agents that are sufficiently host-specific and damaging to have a significant impact on populations.	1. Assess research undertaken so far on the purple blotch fungus, Septocyta ruborum, and the likelihood of finding pathotypes that will solely attack invasive Rubus spp. 2. Perform a survey for new natural enemies in the UK where the most important species, R. anglocandicans, putatively originates from.	A Phytophthora sp. has been linked with the extensive, naturally-occurring dieback of invasive blackberries observed in riparian areas in south-west WA (39 km of river bank affected). Consider developing a non-commercial augmentative biocontrol approach based on this pathogen to deploy in major infestations, since it is unlikely that there would be a market potential for a commercial bioherbicide.
Senecio jacobaea		+	Socioeconomic value	None.	+	Weed life cycle	Biennial species, but can perennate if grazed or mowed. Perennation can result in sustenance of agents across seasons. Seed dispersed by animal and machinery.				
Senecio jacobaea		N	Nomination as target for BC	Never nominated. First agent (Cinnabar moth) introduced in 1930.	+	Type, severity, duration damage	Available agents attack roots, crowns, stem buds and meristematic tissue or plant and can cause severe damage				
Senecio jacobaea		-	Investment opportunities	Mainly a weed of grazing. Some funding provided in the past by the dairy industry.	+	Synchronicity	Good synchronisation of agent damage with weed life cycle (e.g. flea beetle larvae feed on roots for 7-8 months through winter; plume moth and stem and crown boring moth active in spring and summer).				
Senecio jacobaea		+	Logistical - native range	Europe. No access difficulties. No problem with exporting natural enemies. Western Asia could be more problematic for exploration.	+	Sensitiveness to damage	Weed not a good competitor so vigour reduction caused by agents results in a reduction in plant competitiveness.				
Senecio jacobaea		+	Logistical - R&D infrastructure & collaborative links	Australian laboratory in Southern France with necessary R&D infrastructure. A range of collaborative links have been established over the years between Australian and European scientists	+	Habitat	Mainly restricted to pastures in high rainfall areas.				
Senecio jacobaea		-	Ecology - weed origin	Europe and western Asia (Eurasia).	+	Climate	Agents released are well matched with climate where the weed occurs in Australia.				

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Senecio jacobaea		+	Ecology - knowledge of weed	Many of the ecological processes affecting the weed distribution and abundance have been recorded.	+	Parasitism/predation	Not significant for established agents although some recorded.				
Senecio jacobaea			Relatedness to non-targets in Australia	Taxonomy recently revised. There are several native *Senecio* spp. in Australia that are closely related.		Others					
Senecio jacobaea			Knowledge of natural enemies	Excellent. Insect natural enemies in the native range are well known.							
Senecio jacobaea			Richness & HS of potential agents	High richness and information on host-specificity available for some. All agents tested and released were shown to be host specific.							
Senecio jacobaea			Other factors								
Senecio jacobaea	*Senecio jacobaea*	Low	SUMMARY	No new agents expected to be found in the native range that could enhance existing biocontrol.	Low	SUMMARY	Biocontrol program established many years ago and indications is that it is having a major impact.	Low	Biocontrol program established many years ago and having a major impact. No new agents expected to be found in the native range that could enhance existing biocontrol.	No actions identified.	Develop extension activities targeting farmers to facilitate/enhance integration of biocontrol agents with other weed management methods.
Senecio madagascariensis		+	Socioeconomic value	None.	+	Weed life cycle	Long-lived annual/perennial.				
Senecio madagascariensis		+	Nomination as target for BC	Yes.	-	Type, severity, duration damage	High seed reductions required so success comes from reducing plant size prior to flowering. Fireweed in Australia is already attacked by a number of natural enemies that moved over from Australian native *Senecio* spp., so not much more damage may be required to significantly reduce its competitiveness.				
Senecio madagascariensis		-	Investment opportunities	A WoNS. Significant differences in opinion on the ease with which the weed can be managed using grazing and herbicides across regions. Only some areas say it is uncontrollable (South Coast of NSW). Is this due to climate/soil type a function of a newly invaded area or lack of good tech transfer?	N	Synchronicity	No issues.				
Senecio madagascariensis		+	Logistical - native range	Southern Africa. No problem with access, especially South Africa. No problem with exporting natural enemies.	-	Sensitiveness to damage	Seems to be tolerant of quite a lot of damage so would need a natural enemy for which it lacks resistance.				
Senecio madagascariensis		+	Logistical - R&D infrastructure & collaborative links	Long-established collaborative links with world-leading government agency and universities that work on biocontrol of weeds.	N	Habitat	Only a problem in improved pastures and roadsides so habitat quite management specific.				
Senecio madagascariensis		+	Ecology - weed origin	Southern Africa. No doubt about origin. Previous genetic study has pin pointed origin to the Natal province of South Africa.	-	Climate	Potential distribution very high (Far North QLD to Tas), whereas native distribution in southern Africa climatically more restricted.				

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Senecio madagascariensis		+	Ecology - knowledge of weed	Ecology well understood as part of multiple PhDs.	-	Parasitism/predation	Some potential agents may have natural enemies that transfer from native species if similar natural enemies were to be nominated for release				
Senecio madagascariensis		-	Relatedness to non-targets in Australia	Very closely related to Australian native *Senecio* spp., which will mean that it will require highly specific agents (note: all insects on the native species attacks fireweed).		Others					
Senecio madagascariensis		-	Knowledge of natural enemies	Limited at this stage. Early work performed in Madagascar which was not the native range of the species. New ongoing research involves extensive surveys in the South African native range.							
Senecio madagascariensis		-	Richness & HS of potential agents	Likelihood of finding specific agents slight and probably only pathogens rather than insects unless synchrony plays a role .							
Senecio madagascariensis		-	Other factors	Better role of IWM? Local effectiveness could possibly be improved through agent redistribution or IWM							
Senecio madagascariensis	*Senecio madagascariensis*	Low	SUMMARY	Prospect of finding host-specific agents is low as the weed is very closely-related to Australian native *Senecio* spp. Pathogen agents may be the only option.	Low	SUMMARY	Weed already being attacked by natural enemies of native *Senecio* spp. and seems to be tolerant of quite a lot of damage.	Low	A challenging biocontrol target because of its closeness to native *Senecio* spp. and apparent ability to cope with high levels of damage from natural enemies.	1. Continue surveys for natural enemies in South African native range to identify promising candidates. 2. If candidates are found, perform preliminary host-specificity testing on key native Senecio spp. to determine their potential for biocontrol in Australia.	n/a
Senna obtusifolia		+	Socioeconomic value	None	N	Weed life cycle	Perennial				
Senna obtusifolia		+	Nomination as target for BC	Approved.		Type, severity, duration damage	Unknown				
Senna obtusifolia		N	Investment opportunities	Co-invesment with Brazil?, also serious crop weed in USA (legume/herbicide), minor weed with sugar in Qld e.g. Herbert Valley		Synchronicity	Unknown				
Senna obtusifolia		+	Logistical - native range	Native to Mexico and Central America. Access is good.		Sensitiveness to damage	Unknown				
Senna obtusifolia		+	Logistical - R&D infrastructure & collaborative links	Good		Habitat	Unknown				
Senna obtusifolia		+	Ecology - weed origin	Confident of origin which is in a limited area in Central America. Taxonomically moderately well resolved		Climate	Unknown				
Senna obtusifolia		N	Ecology - knowledge of weed	Marie Vitelli has done unpublished pre-release studies. Otherwise relatively poorly studied.		Parasitism/predation	Unknown				

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Senna obtusifolia		-	Relatedness to non-targets in Australia	c 15 native Sennas in Australia including 3 in "Chamaecrista" group to which target belongs. The ?genus also includes a pasture species. Specificity requirements are therefore very high.		Others					
Senna obtusifolia		N	Knowledge of natural enemies	Relatively well surveyed. There is potential for finding further potential agents, including more work in Mexico and central America (only 11wk trip in Honduras by Bill Palmer; Ricardo Segura also conducted informal surveys in Mexico). Native range survey work ended about 1-2 years prematurely.							
Senna obtusifolia		N	Richness & HS of potential agents	Approximately 90 species recorded (Kim Pullen paper). Native range work terminated 1-2 yrs prematurely, as was work on pot agents. Sufficiently host-specific species not yet found. One agent tested but not sufficiently host-specific, one agent imported but died out.							
Senna obtusifolia		N	Other factors								
Senna obtusifolia	*Senna obtusifolia*	Low	SUMMARY	Likely to find further Senna specialists, but finding sufficiently host-specific insects for Australia seems unlikely.	Low	SUMMARY	Low based on absence of potential agents.	Low	Further potential agents is unconsidered unlikely, in part owing to high host-specificity requirements.	1. Gap analysis of previous survey efforts, with possibility of a few more years of targeted survey work in Central America. Possibly target pathogens with higher likelihood of specificity.	n/a
Solanum elaeagnifolium		+	Socioeconomic value	None.	-	Weed life cycle	Summer-growing perennial herb. Extensive and deep perennial roots make it extremely competitive. Regenerates from seed or from rhizomatous root material.				
Solanum elaeagnifolium		+	Nomination as target for BC	Yes.	+	Type, severity, duration damage	Severe and continuous defoliation by the leaf-feeding beetle *Leptinatarsa texana* in South Africa has been substantial and the weed is no longer problem in summer-rainfall areas (note this agent cause minor damage on eggplant and would unlikely ever get permission for release in Australia). Attack to stems would be ideal but agents that inflict such damage may not have the required specificity.				
Solanum elaeagnifolium		+	Investment opportunities	Also a cropping weed and a WoNS.	+	Synchronicity	Could be a problem since all aerial parts die in autumn. However, no evidence of asynchrony with released agents in South Africa.				

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Solanum elaeagnifolium		N	Logistical - native range	No logistic issues, including problems to export agents, in USA. South America is also included in native range. Exploration in this region would face more logistical problems and also the prospect of not being able to export candidate agents.	-	Sensitiveness to damage	Has an extensive root system and therefore would have potential to recover from damage if not severe and persistent.				
Solanum elaeagnifolium		+	Logistical - R&D infrastructure & collaborative links	R&D infrastructure in the USA very good and high potential to build collaborative links. Some collaborative links also in place in South America. Already established collaborative links with South Africans could be useful since agents have already been released in that country for this weed.	N	Habitat	Not confined to particular soil type.				
Solanum elaeagnifolium		+	Ecology - weed origin	South west USA or northern Mexico and South America (although there is disagreement on this). The precise origin of Australia populations has not yet been determined, although a genetic study is currently underway (by USDA, France).	-	Climate	Warm temperate regions, reasonably well matched to putative regions of origin, south west USA and Mexico, South America. There is likely to be a poor climate match to Mediterranean regions which may influence agent selection.				
Solanum elaeagnifolium		+	Ecology - knowledge of weed	Biology of Australian populations known. Genetic diversity in Australia has been studies and revealed that two distinct gene pools exist	N	Parasitism/predation	Unknown, depending on agents that would be released.				
Solanum elaeagnifolium		-	Relatedness to non-targets in Australia	Belongs to the family Solanaceae. There are several economically important (e.g. eggplant, potato, capsicum) and native species in the *Solanum* genus in Australia.		Others					
Solanum elaeagnifolium		+	Knowledge of natural enemies	Natural enemies well-explored in North America, Mexico and parts of South America. Several surveys have been performed, especially by the South Africans. Chile and central regions of Argentina have not been surveyed.							
Solanum elaeagnifolium		+	Richness & HS of potential agents	Rich fauna in native range - few are host specific although there is indications from field observations that some may be.							
Solanum elaeagnifolium			Other factors								

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Solanum elaeagnifolium	*Solanum elaeagnifolium*	Low	SUMMARY	There are some prospects of finding highly host-specific insect agents considering the rich fauna in the native range and preliminary assessments undertaken. However, priority should be given to potential agents known to be highly-specific such as mites and fungal pathogens. Surveys in unexplored regions of Argentina and Chile may reveal additional candidate agents.	Mod	SUMMARY	Evidence from South Africa that severe and continuous defoliation can have a major impact on the weed, even though it has an extensive root system. On this basis, it may be possible to find sufficiently damaging agents.	Low-Mod	A challenging biocontrol target because of its closeness to economically important and native Solanum spp. There is however, evidence from South Africa that it can be successfully control by defoliating agents.	1. Carry out additional surveys for natural enemies if the precise origin of Australian populations in the native range, which is currently being identified in an international genetic study, corresponds to regions that have never before been explored.	n/a
Sporobulus spp.		+	Socioeconomic value	Low value as drought fodder	-	Weed life cycle	High seed production. A grass, that are typically challenging targets.				
Sporobulus spp.		+	Nomination as target for BC	All species approved. All declared noxious.	-	Type, severity, duration damage	Expected to be challenging as a grass. Pathogens likely to be the best prospect.				
Sporobulus spp.		N	Investment opportunities	Not yet recogonised as important environmental weeds.	N	Synchronicity					
Sporobulus spp.		+	Logistical - native range	Know weed origin fairly well in a general sense. Can get into most of native range	_	Sensitiveness to damage	As a grass is expected to be challenging. Adapted to severe defoliation.				
Sporobulus spp.		N	Logistical - R&D infrastructure & collaborative links	Access possible depending on exact area	N	Habitat					
Sporobulus spp.		N	Ecology - weed origin	Very broad covering, Asia, Africa and Americas. Not sure how well native range of individual species is delimited. Further taxonomic work is probably required.	N	Climate	Large introduced range				
Sporobulus spp.		N	Ecology - knowledge of weed	Not particularly well studied.	N	Parasitism/predation	No information.				
Sporobulus spp.		-	Relatedness to non-targets in Australia	About 14 native Sporobulus species, and potential agents known to cross over. Exotics thought to be in different "pyrmidalis group"	-	Others	Five target species from different native ranges.				
Sporobulus spp.		-	Knowledge of natural enemies	Could do more surveying, including Asia (fertilis) or USA (jacqumonti), perhaps more could be done in South Africa							
Sporobulus spp.		-	Richness & HS of potential agents	Typically depauperate (lots of casuals), and not host-specific. Only found smut but it went on Australian natives, and a wasp that couldn't be cultured.							
Sporobulus spp.		+	Other factors	Native sporobulus ecologically at least appear to be very different to exotic species.							

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Sporobulus spp.	*Sporobulus* spp.	Low	SUMMARY	Relatively well surveyed. High host-specificity requirements that have not yet been met.	Low	SUMMARY	Expected to be difficult to find sufficiently damaging agents, based on previous work on Sporobulus, as well as on Nasella.	Low	Further options for surveying, but likelihood of finding sufficiently host specific and damaging agents remains lows.	1. Gap analysis of previous survey efforts and further delimitation of native ranges, potentially leading to further searches in Asia and the USA (and possibly southern Africa). This would include taxonomic work to confirm the species we have in Australia, and to help delimit their native ranges.	Explore whether Nigrospora oryzae, which causes crown rot of Sporobulus spp., can be developed into a non-commercial augmentative biocontrol approach to deploy in major infestations, since it is unlikely that there would be a market potential for a commercial bioherbicide.
Themeda quadrivalvis		+	Socioeconomic value	Of no value.		Weed life cycle	Annual				
Themeda quadrivalvis		N	Nomination as target for BC	Not nominated as target, but don't expect significant problems		Type, severity, duration damage	Expected to be challenging as a grass				
Themeda quadrivalvis		N	Investment opportunities	Also viewed as an environmental weed.		Synchronicity					
Themeda quadrivalvis		N	Logistical - native range	Some dispute about native range, but probably includes India		Sensitiveness to damage	Expect it to be highly resistant to herbivory.				
Themeda quadrivalvis		N	Logistical - R&D infrastructure & collaborative links	Ok if India.		Habitat	Unknown				
Themeda quadrivalvis		-	Ecology - weed origin	Poorly understood, different views in literature. Unresolved.		Climate	Likely to occur in simlar climates in native range.				
Themeda quadrivalvis		+	Ecology - knowledge of weed	Relatively well understood in Australia.		Parasitism/predation	Unknown				
Themeda quadrivalvis		-	Relatedness to non-targets in Australia	Many native Themeda species.		Others					
Themeda quadrivalvis		-	Knowledge of natural enemies	Little known, requires review.							
Themeda quadrivalvis		-	Richness & HS of potential agents	Expect fauna to be depauperate based on it being a grass.							
Themeda quadrivalvis			Other factors								
Themeda quadrivalvis	*Themeda quadrivalvis*	Low	SUMMARY	Poorly studied in its native range, but expect natural enemies to be depauperate.	Low	SUMMARY	Expected to be difficult to find sufficiently damaging agents based on precedence of other grasses.	Low	Poorly studied species but, in the absence of further study, expect it to be a difficult target.	1. Nominate as target. 2. Conduct review of available information, and prioritise actions for a biocontrol program.	n/a
Ulex europaeus		+	Socioeconomic value	None, although beekeepers had concerns at the time gorse was nominated as biocontrol target.	-	Weed life cycle	Perennial shrub with high seed outputs. A hardy target.				
Ulex europaeus		+	Nomination as target for BC	Yes.	N	Type, severity, duration damage	Available agents consist of one seed feeder and three foliage feeders. Agents constrained either by predation or the effects of gorse phenology. Nonetheless some damage is inflicted.				

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Ulex europaeus		+	Investment opportunities	Also an environmental weed and a WoNS.	-	Synchronicity	12-55% of seeds destroyed annually by gorse seed weevil, but significant proportion of annual seed crop escapes attack (larvae not present in autumn/winter). Gorse thrips enters reproductive diapause and feeds actively only on growth produced in spring and early-mid summer. Gorse soft shoot moth only attacks new growth in spring.				
Ulex europaeus		+	Logistical - native range	Western Europe. Easy access. No political or social hurdles.	-	Sensitiveness to damage	Weed has high capacity to sustain damage. Also at least 75% of seed has to be destroyed to contain weed				
Ulex europaeus		+	Logistical - R&D infrastructure & collaborative links	Excellent. History of strong collaborative links in Europe and also with New Zealand where the plant is a problem	-	Habitat	Wide range, but may not be restrictive for established agents - still unknown.				
Ulex europaeus		+	Ecology - weed origin	United Kingdom is probably the origin of Australian populations since the plant was introduced as a hedge by early settlers.	+	Climate	Agents well-matched to south eastern Australian climate.				
Ulex europaeus		+	Ecology - knowledge of weed	Ecological processes affecting distribution and abundance in published literature.	N	Parasitism/predation	Gorse spider mite restricted by predators. Other three agents not significantly affected.				
Ulex europaeus		-	Relatedness to non-targets in Australia	No other *Ulex* spp. in Australia, but it is related to some crop plants in the Fabaceae (e.g. lupins).		Others	Available agents may have long-term impact through sub-lethal effect on maximum plant age and increasing susceptibility to fungal attack as well as primary feeding damage causing vigour reduction.				
Ulex europaeus		+	Knowledge of natural enemies	Excellent; based on the many European surveys undertaken over the years.							
Ulex europaeus		-	Richness & HS of potential agents	Over 100 natural enemies recorded but very few host-specific (probably not many more than the four agents released)							
Ulex europaeus		-	Other factors	Additional European surveys (mid 2000s) and investigations have not revealed additional invertebrate and fungal species that are sufficiently host-specific.							
Ulex europaeus	*Ulex europaeus*	Low	SUMMARY	No new agents expected to be found in the native range that could enhance existing biocontrol.	Low	SUMMARY	Few prospects to find new agents capable of causing major damage, since all options have been investigated.	Low	All possible available agents have already been released and having some impact, although spread has been slow for some.	No actions identified.	Distribute the most promising agent, soft shoot moth, which is slow to build up populations and spread, to areas of south-eastern Australia where it is not present. Evaluate/quantify the impact of agents released, assess if impact can be enhanced through IWM and develop recommendations for farmers. Investigate the natural dieback that has recently been observed in Tas and assess if this could be exploited to enhance biocontrol.
Vachellia nilotica ssp. *indica* (syn. *Acacia nilotica* ssp. *indica)*		+	Socioeconomic value	Minor benefits, but overwhelmed by negative impacts, and therefore not sufficient to limit bc	-	Weed life cycle	Perennial plant.				

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Vachellia nilotica ssp. *indica* (syn. *Acacia nilotica* ssp. *indica)*		+	Nomination as target for BC	Already an approved target for BC	-	Type, severity, duration damage	Prickly acacia is susceptible to leaf and shoot damage (Dhileepan et al. 2009) but can recover from extensive mechanical damage. Future effects will focus on the leaf-weevils (D. denticollis and Phachnephorus sp.). Weed not seed limited, has a long-lived seed bank and undergoes seasonal leaf-loss. High levels of prolonged defoliation expected to be required to cause impacts.				
Vachellia nilotica ssp. *indica* (syn. *Acacia nilotica* ssp. *indica)*		N	Investment opportunities	Also an environmental weed and potentially causes water issues (but all funding has essentially been as a pastoral weed).	-	Synchronicity	Shows seasonal leaf loss. Insects synchronised to growing seasons in native range (summer/rainy season).				
Vachellia nilotica ssp. *indica* (syn. *Acacia nilotica* ssp. *indica)*		+	Logistical - native range	India logistically good now that contacts are in place. Pakistan not accessible but may have same fauna as India and has previously been explored.	-	Sensitiveness to damage	Can recover from extensive mechanical damage. Scale insects cause seedling mortality and shoot dieback in mature trees in both India and Bangladesh (Baksha and Islam 1996; Dhileepan et al. 2013). In exlusion trials in Tamil Nadu, damage by native insects significantly reduced the plant height and biomass (unpublished data). However, these insects have been excluded as agents. Impact of remaining agents is not known.				
Vachellia nilotica ssp. *indica* (syn. *Acacia nilotica* ssp. *indica)*		+	Logistical - R&D infrastructure & collaborative links	Good in India where current focus is, and surveys in other countries have historically been well supported	+	Habitat	Broad. In the native range, prickly acacia occurs across a wide range of habitats, from sandy desert to artificial lakes where the prickly acacia is subjected to prolonged submersion under water.				
Vachellia nilotica ssp. *indica* (syn. *Acacia nilotica* ssp. *indica)*		+	Ecology - weed origin	Well known for species and sub-species (morphologically, supported by genetics).	N	Climate	Relatively narrow target climate range, but even then some existing agents only perform in parts of that range. May be difficult to find any one agent that will perform as well across distribution. Climate range wide in native range, and includes similar climate to Australia.				
Vachellia nilotica ssp. *indica* (syn. *Acacia nilotica* ssp. *indica)*		+	Ecology - knowledge of weed	Ecology well studied in Australia and quite well understood across native range	N	Parasitism/predation	Not known for leaf-feeders.				
Vachellia nilotica ssp. *indica* (syn. *Acacia nilotica* ssp. *indica)*		-	Relatedness to non-targets in Australia	Lots of native acacia (including 8 species in *Vachellia*), many of which are unacceptably damaged by some insects in lab tests.	N	Others	Remaining agents to test: Dereodus denticollis, Phycita sp. B., Phachnophorus sp.				
Vachellia nilotica ssp. *indica* (syn. *Acacia nilotica* ssp. *indica)*		-	Knowledge of natural enemies	Species and subspecies both comprehensively surveyed across India, Pakistan, South Africa and Kenya. Well documented. Further exploration is not expected to yield further species.							

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Vachellia nilotica ssp. *indica* (syn. *Acacia nilotica* ssp. *indica)*		-	Richness & HS of potential agents	High species richness across the various subspecies, but only three more insects to test (host-specificity still unknown and so far unable to rear): leaf-weevils (D. denticollis and Phachnephorus sp.) and leaf-feeding moth Phycita sp. B (Pyralidae). Further potential agents unlikely to be found beyond that. Sufficiently specific agents (based on both laboratory tests and field host range) have been very difficult to find, and some potential agents have been too specific (to the wrong sub-species)							
Vachellia nilotica ssp. *indica* (syn. *Acacia nilotica* ssp. *indica)*		-	Other factors	The only other option for finding new species is to further survey other subspecies in Africa, but unexplored regions are largely restricted to countries that are now dangerous or difficult to work in (e.g. Somalia).							
Vachellia nilotica ssp. *indica* (syn. *Acacia nilotica* ssp. *indica)*	*Vachellia nilotica* ssp. *indica* (syn. *Acacia nilotica* ssp. *indica)*	Mod	SUMMARY	Native range now comprehensively surveyed. Only three more potential agents (of unknown host-specificity and unable to be reared). Further survey work not expected to yield additional agents.	Low	SUMMARY	Would generally be considered to be a difficult target and existing agents have failed to reach high densities across the climatic range. Impact of remaining potential agents is not known, but would require high levels of prolonged attack.	Low-Mod	Only three remaining potential agents, all leaf-feeders of unknown host-specificity which currently can't be cultured. Impact will probably require high levels of prolonged defoliation.	1. Finalise testing of 3 remaining potential insects, and follow through if expected to cause required impact and are safe. 2. Critically assess past exploration/testing work to determine whether other options are available.	Redistribution not required. No actions identified. Explore whether natural dieback phenomenon can be exploited.
Vulpia spp.		-	Socioeconomic value	Conflict most likely to occur. Vulpia is a winter annual grass species that can provide green feed of reasonable quality after the autumn break and through early winter. It has however, poor winter herbage production and low palatability.		Weed life cycle					
Vulpia spp.		-	Nomination as target for BC	No.		Type, severity, duration damage					
Vulpia spp.		-	Investment opportunities	None.		Synchronicity					
Vulpia spp.		+	Logistical - native range	Mediterranean regions. Easy access. No political or social hurdles.		Sensitiveness to damage					
Vulpia spp.			Logistical - R&D infrastructure & collaborative links	Well-established infrastructure and potential for collaborative links high considering past experiences.		Habitat					
Vulpia spp.		+	Ecology - weed origin	Mediterranean region.		Climate					
Vulpia spp.			Ecology - knowledge of weed	Studied extensively in Australia during the first Weeds CRC. Some research also done by CSIRO in France.		Parasitism/predation					

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Vulpia spp.		-	Relatedness to non-targets in Australia	In the grass subfamily Festucoideae, which also comprises desirable grazing species (*Festuca* spp. and *Lolium* spp.). Artificial intergeneric hybridization of *Vulpia* and *Festuca* spp. have been produced.		Others					
Vulpia spp.		-	Knowledge of natural enemies	Limited, although some surveys have been done in France.							
Vulpia spp.		-	Richness & HS of potential agents	Ditto							
Vulpia spp.			Other factors								
Vulpia spp.	*Vulpia* spp.	Unfeasible	SUMMARY	Because of its palatability when young, it is most likely that a conflict would occur should this species be proposed as a biocontrol target.	n/a	SUMMARY	n/a	Unfeasible	Unsuitable for classical biocontrol. Desirable fodder at some times of the year.	No actions identified.	n/a
Xanthium occidentale (syn *X. strumarium*)		+	Socioeconomic value	None.	-	Weed life cycle	Weed is often ephemeral along water courses and this has been one of the problems for populations of agents to sustain themselves in areas where control is not currently effective.				
Xanthium occidentale (syn *X. strumarium*)		+	Nomination as target for BC	Yes, before formal nomination process was put in place.	-	Type, severity, duration damage	Sustained defoliation and stem infection by the rust in south-east QLD has been highly effective in controlling population. Infection by secondary fungi may have contributed to this success. Effectiveness of rust depends on high humidity.				
Xanthium occidentale (syn *X. strumarium*)		-	Investment opportunities	Also an environmental weed. Lots of work has been done on biocontrol of this species. Recent additional work performed specifically targeted tropical areas of Central America to find strains of the rust *Puccinia xanthii* better suited to northern Australia, where biocontrol effectiveness has been limited. Matching between weed and rust genotypes was not found and research was terminated.	-	Synchronicity	Damage needs to happen early in season before fruits are produced.				
Xanthium occidentale (syn *X. strumarium*)		N	Logistical - native range	If we assume that the origin of Australian populations is southern USA, then there are no logistical hurdles for exploration. Central and South America are also included in native range. Exploration in these regions would face more logistical problems and also the prospect of not being able to export candidate agents.	+	Sensitiveness to damage	Based on observations with the rust, the plant seems to be sensitive to defoliation, especially if stems are affected.				

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Xanthium occidentale (syn *X. strumarium*)		+	Logistical - R&D infrastructure & collaborative links	R&D infrastructure in the USA very good and high potential to build collaborative links. Some collaborative links also in place in Central and South America.	-	Habitat	Infestations are often the result of previous flooding, which means that often there are often no populations of the plant nearby on which agents have been able to sustain themselves.				
Xanthium occidentale (syn *X. strumarium*)		+	Ecology - weed origin	X. strumarium sensu lato is found in southern USA and Central and South America. There are pointers that Australian populations probably originate from southern USA. Genetic work is required to confirm this.	-	Climate	The climate where the rust fungus has not been effective is dry and/or hot.				
Xanthium occidentale (syn *X. strumarium*)		+	Ecology - knowledge of weed	Biology relatively well studied. *Xanthium* taxonomy is contentious with some taxonomists lumping many species in X. strumarium sensu lato		Parasitism/predation					
Xanthium occidentale (syn *X. strumarium*)		N	Relatedness to non-targets in Australia	No native *Xanthium* spp in Australia. It is however, in the same tribe as the crop sunflower and ornamentals such as *Calendula* and *Zinnia* spp.		Others					
Xanthium occidentale (syn *X. strumarium*)		+	Knowledge of natural enemies	Has been extensively surveyed in native range over many years before and after WWII.							
Xanthium occidentale (syn *X. strumarium*)		+	Richness & HS of potential agents	All insect agents found in USA and Mexico that were sufficiently host-specific have been released in Australia. Rust fungus *P. xanthii* was accidentally or illegally introduced (origin unknown) and although it was found on sunflower and calendula soon after its introduction it has never been an issue for these non-target species.							
Xanthium occidentale (syn *X. strumarium*)			Other factors								
Xanthium occidentale (syn *X. strumarium*)	*Xanthium occidentale* (syn *X. strumarium*)	Low	SUMMARY	All known, host-specific insect agents from USA and Mexico have already been released. Additional agents may be found in other regions of Central and South America since they have been unexplored. It will remain a challenge to find compatible rust genotypes better adapted to hot/dry climates to enhance biocontrol in areas where the rust is currently not effective in Australia.	Low	SUMMARY	Few prospects to find suitable new agents. Defoliation and stem attack prior to flowering has been shown to be efficient in reducing populations. Weed is often ephemeral along water courses and this has been one of the problems for populations of agents to sustain themselves.	Low	There are limited options to enhance biocontrol of this weed, especially because of its ephemeral nature. New agents or rust strains would need to be well adapted to hot/dry climates where biocontrol is not currently effective.	1. Carry out a survey in Central and South America to identify new potential agents.	Survey southern USA for compatible strains of the rust fungus that already occurs in Australia, which could be better adapted to hot/dry climates. Existing insect agents have limited impact and the existing rust strain has reached it eco-climatic limits, therefore redistribution of those agents likely to have limited benefit.
Xanthium spinosum		+	Socioeconomic value	None.	N	Weed life cycle	Summer annual herb.				
Xanthium spinosum		-	Nomination as target for BC	No.	-	Type, severity, duration damage	Girdling stem damage appears to be the most effective in preventing fruiting and depending on position on stems even killing plants.				

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Xanthium spinosum		+	Investment opportunities	Also a cropping weed (irrigated summer crops).	-	Synchronicity	Flowers all year round, but mostly in summer/autumn. Damage needs to happen early in season before fruits are produced.				
Xanthium spinosum		-	Logistical - native range	South America. Main logistical hurdles would be to obtain permission to export agents.	+	Sensitiveness to damage	Based on observations with the bioherbicide fungus, the plant is sensitive to defoliation, especially if stems are affected				
Xanthium spinosum		N	Logistical - R&D infrastructure & collaborative links	Some collaborative links already established.	-	Habitat	Grows in high-fertility disturbed soil, especially along watercourses and around dams, but it also grows well in drier conditions.				
Xanthium spinosum		+	Ecology - weed origin	East of the Andes in South America, probably Argentina.	+	Climate	Predominantly in temperate climate.				
Xanthium spinosum		+	Ecology - knowledge of weed	Good knowledge, mainly gathered as part of the bioherbicide development research targeting this species.		Parasitism/predation					
Xanthium spinosum		N	Relatedness to non-targets in Australia	No native *Xanthium* spp in Australia. It is however, in the same tribe as the crop sunflower and ornamentals such as *Calendula* and *Zinnia* spp.		Others					
Xanthium spinosum		+	Knowledge of natural enemies	Several surveys for arthropods and fungi natural enemies have been performed in the native range (1930-40s and 1990s).							
Xanthium spinosum		-	Richness & HS of potential agents	Relatively rich fauna observed but no arthropods agents ever released (lack of specificity, low impact or not investigated). Several fungi also found during surveys, but not released due to lack of specificity.							
Xanthium spinosum		-	Other factors	The native range search for new strains of the fungus *Colletotrichum orbiculare* , which already occurred in Australia, that are effective under drier climates was not successful and no additional strains were released in Australia was never commercialised due to low market potential.							
Xanthium spinosum	*Xanthium spinosum*	Low	SUMMARY	Considering previous work, the possibility of finding new agents not previously considered is low. Stem-borer and stem-miner insects found in Argentina and Chile in the 1990s that have not been investigated may have potential, although may be found not to be sufficiently host-specific.	Low	SUMMARY	Few prospects to find new agents capable of causing major damage since most options have been investigated. Defoliation only, without stem attack, would not be sufficient to control plants unless they are associated with a vigorous pasture.	Low	There are limited options to enhance biocontrol of this weed considering the amount of efforts that have already been expanded.	1. Collect stem-borer and stem-miner insects found in Argentina and Chile in the 1990s. 2. Perform preliminary host-specificity tests, especially on sunflower, to determine if they have any potential for biocontrol.	Consider developing a non-commercial augmentative biocontrol approach to enhance the efficacy of the existing Colletotrichum orbiculare pathogen that affects the weed, since the market potential for a commercial bioherbicide is too low to justify costs of development.
Ziziphus mauritiana		N	Socioeconomic value	Commercial fruit overseas, but not expected to be of much value in Australia. Invasive type not particularly palatable.	N	Weed life cycle	Perennial, wet/dry seasonal cycle of growth.				

Taxa	Master line	Feasibility-rank	Feasibility-attribute	Feasibility-rationale	Likelihood-rank	Success likelihood-attribute	Likelihood-rationale	Biocontrol prospects-rank	Biocontrol prospects explanation	New agents–Key investment area(s)	Existing natural enemies/released agents–Potential investment area(s)
Ziziphus mauritiana		N	Nomination as target for BC	Not nominated as target, but don't expect significant problems	-	Type, severity, duration damage	Most likely impact through reduced seed production to slow spread.				
Ziziphus mauritiana		-	Investment opportunities	Only pastoralist interests at the moment.	-	Synchronicity	Seeding is highly seasonal, also in native range, need seed-feeders that can deal with that.				
Ziziphus mauritiana		N	Logistical - native range	Good access to native range, but spread widely so actual native range may be difficult to delimit.	-	Sensitiveness to damage	Extremely good at regrowing from severe, sustained damage to leaves and stems. Would require high level of sustained damage.				
Ziziphus mauritiana		N	Logistical - R&D infrastructure & collaborative links	Patchy. India and China is good.	-	Habitat	Occurs in wide range of habitats				
Ziziphus mauritiana		N	Ecology - weed origin	Widespread in Southern Asia, India and elsewhere. Native range still to be properly delimited.	?	Climate	Not sure of climate match of native and introduced ranges				
Ziziphus mauritiana		+	Ecology - knowledge of weed	Good knowledge in Australia.	?	Parasitism/predation	No information.				
Ziziphus mauritiana		-	Relatedness to non-targets in Australia	Two native Ziziphus (170 spp in genus), other Rhamnaceae native.		Others					
Ziziphus mauritiana		N	Knowledge of natural enemies	Good knowledge of natural enemies of horticultural impact. Ad hoc surveys in native range only							
Ziziphus mauritiana		+	Richness & HS of potential agents	About 30 natural enemies recorded, including at least a of couple of host-specific insects. Further potential agents expected from additional surveys.							
Ziziphus mauritiana			Other factors								
Ziziphus mauritiana	*Ziziphus mauritiana*	Mod	SUMMARY	Expect a relatively rich fauna, although may have trouble with host-specificity requirements.	Low	SUMMARY	Expected to be a difficult target, although reducing spread rates is a relatively modest objective. Likelihood of success might increase subject to results from targeted surveys.	Low-Mod	A largely unexplored target. Expect to find potential agents, but too early to properly assess likelihood of success.	1. Assess whether biocontrol is better than diligent targeting of large-seeding trees. 2. Assess potential for targeting biocontrol to reduce seed production.	n/a

CURRENTXPOTENTIAL IMP WORKSHEET

Row Labels	Count of Potential impact (Negligible, low, moderate, high)
Neg	**11**
Neg	**10**
Cenchrus longispinus and C. incertus	1
Diplotaxis tenuifolia	1
Erodium cicutarium	1
Galium tricornutum	1
Hypochaeris spp.	1
Hyptis suaveolons	1
Mimosa diplotricha var. diplotricha (syn. Mimosa invisa)	1
Rumex spp.	1
Tamarix aphylla	1
Tribulus terrestris	1
Low	**1**
Senecio jacobaea	1
Low	**24**
Neg	**4**
Cenchrus pedicellatus and C. polystachios	1
Lantana montevidensis	1
Senna obtusifolia	1
Themeda quadrivalvis	1
Low	**17**
Arctotheca calendula	1
Asphodelus fistulosus	1
Calotropis procera	1
Carduus nutans	1
Carthamus lanatus	1
Cirsium arvense	1
Harrisia martinii	1
Hordeum spp.	1
Marrubium vulgare	1
Mimosa pigra	1
Parkinsonia aculeata	1
Raphanus raphanistrum	1
Reseda lutea	1
Rosa rubiginosa	1
Vulpia spp.	1
Xanthium occidentale (syn X. strumarium)	1
Xanthium spinosum	1
Mod	**3**
Echium plantagineum	1
Hypericum perforatum	1
Onopordum spp.	1
Mod	**38**
Neg	**7**
Chromolaena odorata	1
Cylindropuntia aurantica	1
Cylindropuntia fulgida	1

Row Labels	Count of Potential impact (Negligible, low, moderate, high)
Cylindropuntia imbricata	1
Cylindropuntia rosea	1
Cylindropuntia tunicata	1
Opuntia monocantha	1
Low	**12**
Andropogon gayanus	1
Bryophyllum delagoense	1
Cytisus scoparius	1
Emex australis	1
Euphorbia terracina	1
Hyparrhenia hirta	1
Jatropha gossypiifolia	1
Opuntia & Cylindropuntia spp.	1
Physalis viscosa	1
Sporobolus africanus	1
Sporobolus jacquemontii	1
Ziziphus mauritiana	1
Mod	**19**
Carduus tenuiflorus and C. pycnocephalus	1
Cirsium vulgare	1
Cryptostegia grandiflora	1
Eragrostis curvula	1
Lycium ferocissimum	1
Moraea flaccida and M. miniata	1
Nassella neesiana	1
Nassella trichotoma	1
Parthenium hysterophorus	1
Phyla canescens	1
Romulea rosea	1
Rubus fruticosus agg. (primarily R. anglocandicans)	1
Senecio madagascariensis	1
Solanum elaeagnifolium	1
Sporobolus fertilis (syn S. indicus var. major)	1
Sporobolus natalensis	1
Sporobolus pyramidalis	1
Sporobulus spp.	1
Ulex europaeus	1
High	**4**
Neg	**1**
Opuntia robusta	1
Low	**1**
Prosopis spp.	1
High	**2**
Lantana camara	1
Vachellia nilotica spp. indica (syn. Acacia nilotica)	1
Grand Total	**77**

PROSPECTXCURRENT IMP WORKSHEET

Inclusion in biocontrol assessment (yes, combined or no; no is selected when weed has Negligible current and potential impact)	Yes

Row Labels	Count of Current impact (Negligible, low, moderate, high)
Neg	**5**
Low	**3**
Cenchrus pedicellatus and C. polystachios	1
Senna obtusifolia	1
Themeda quadrivalvis	1
Mod	**1**
Lantana montevidensis	1
High	**1**
Chromolaena odorata	1
Low	**29**
Unfeasible	**2**
Hordeum spp.	1
Vulpia spp.	1
Low	**14**
Andropogon gayanus	1
Carduus nutans	1
Cytisus scoparius	1
Emex australis	1
Harrisia martinii	1
Hyparrhenia hirta	1
Mimosa pigra	1
Parkinsonia aculeata	1
Raphanus raphanistrum	1
Reseda lutea	1
Rosa rubiginosa	1
Senecio jacobaea	1
Xanthium occidentale (syn X. strumarium)	1
Xanthium spinosum	1
Low-Mod	**6**
Arctotheca calendula	1
Bryophyllum delagoense	1
Carthamus lanatus	1
Jatropha gossypiifolia	1
Physalis viscosa	1
Ziziphus mauritiana	1
Mod	**4**
Asphodelus fistulosus	1
Calotropis procera	1
Cirsium arvense	1
Euphorbia terracina	1
Mod-High	**3**
Marrubium vulgare	1
Opuntia & Cylindropuntia spp.	1
Prosopis spp.	1
Mod	**19**
Unfeasible	**1**
Eragrostis curvula	1

Inclusion in biocontrol assessment (yes, combined or no; no is selected when weed has Negligible current and potential impact)	Yes

Row Labels	Count of Current impact (Negligible, low, moderate, high)
Low	**11**
Cryptostegia grandiflora	1
Echium plantagineum	1
Hypericum perforatum	1
Nassella trichotoma	1
Onopordum spp.	1
Parthenium hysterophorus	1
Phyla canescens	1
Rubus fruticosus agg. (primarily R. anglocandicans)	1
Senecio madagascariensis	1
Sporobulus spp.	1
Ulex europaeus	1
Low-Mod	**3**
Nassella neesiana	1
Romulea rosea	1
Solanum elaeagnifolium	1
Mod	**2**
Carduus tenuiflorus and C. pycnocephalus	1
Lycium ferocissimum	1
Mod-High	**2**
Cirsium vulgare	1
Moraea flaccida and M. miniata	1
High	**2**
Low-Mod	**1**
Vachellia nilotica spp. indica (syn. Acacia nilotica)	1
Mod	**1**
Lantana camara	1
Grand Total	**55**

PROSPECTXPOTENTIAL IMP WORKSHEET

Inclusion in biocontrol assessment (yes, combined or no; no is selected when weed has Negligible current and potential impact)	Yes

Row Labels	Count of Potential impact (Negligible, low, moderate, high)
Neg	**1**
Low	**1**
Senecio jacobaea	1
Low	**24**
Unfeasible	**2**
Hordeum spp.	1
Vulpia spp.	1
Low	**15**
Carduus nutans	1
Cenchrus pedicellatus and C. polystachios	1
Echium plantagineum	1
Harrisia martinii	1
Hypericum perforatum	1
Mimosa pigra	1
Onopordum spp.	1
Parkinsonia aculeata	1
Raphanus raphanistrum	1
Reseda lutea	1
Rosa rubiginosa	1
Senna obtusifolia	1
Themeda quadrivalvis	1
Xanthium occidentale (syn X. strumarium)	1
Xanthium spinosum	1
Low-Mod	**2**
Arctotheca calendula	1
Carthamus lanatus	1
Mod	**4**
Asphodelus fistulosus	1
Calotropis procera	1
Cirsium arvense	1
Lantana montevidensis	1
Mod-High	**1**
Marrubium vulgare	1
Mod	**27**
Unfeasible	**1**
Eragrostis curvula	1
High	**1**
Chromolaena odorata	1
Low	**12**
Andropogon gayanus	1
Cryptostegia grandiflora	1
Cytisus scoparius	1
Emex australis	1
Hyparrhenia hirta	1
Nassella trichotoma	1
Parthenium hysterophorus	1
Phyla canescens	1

Inclusion in biocontrol assessment (yes, combined or no; no is selected when weed has Negligible current and potential impact)	Yes

Row Labels	Count of Potential impact (Negligible, low, moderate, high)
Rubus fruticosus agg. (primarily R. anglocandicans)	1
Senecio madagascariensis	1
Sporobulus spp.	1
Ulex europaeus	1
Low-Mod	**7**
Bryophyllum delagoense	1
Jatropha gossypiifolia	1
Nassella neesiana	1
Physalis viscosa	1
Romulea rosea	1
Solanum elaeagnifolium	1
Ziziphus mauritiana	1
Mod	**3**
Carduus tenuiflorus and C. pycnocephalus	1
Euphorbia terracina	1
Lycium ferocissimum	1
Mod-High	**3**
Cirsium vulgare	1
Moraea flaccida and M. miniata	1
Opuntia & Cylindropuntia spp.	1
High	**3**
Low-Mod	**1**
Vachellia nilotica spp. indica (syn. Acacia nilotica)	1
Mod	**1**
Lantana camara	1
Mod-High	**1**
Prosopis spp.	1
Grand Total	**55**

FEASIBILITYXLIKELIHOOD WORKSHEET

Inclusion in biocontrol assessment (yes, combined or no; no is selected when weed has Negligible cu	Yes

Row Labels	Count of Likelihood of success of biocontrol program (low, Moderate, high) (see guidelines)
n/a	**3**
Unfeasible	**3**
Eragrostis curvula	1
Hordeum spp.	1
Vulpia spp.	1
Low	**34**
Low	**28**
Andropogon gayanus	1
Carduus nutans	1
Cenchrus pedicellatus and C. polystachios	1
Cryptostegia grandiflora	1
Cytisus scoparius	1
Echium plantagineum	1
Emex australis	1
Harrisia martinii	1
Hyparrhenia hirta	1
Hypericum perforatum	1
Mimosa pigra	1
Nassella trichotoma	1
Onopordum spp.	1
Parkinsonia aculeata	1
Parthenium hysterophorus	1
Phyla canescens	1
Raphanus raphanistrum	1
Reseda lutea	1
Rosa rubiginosa	1
Rubus fruticosus agg. (primarily R. anglocandicans)	1
Senecio jacobaea	1
Senecio madagascariensis	1
Senna obtusifolia	1
Sporobulus spp.	1
Themeda quadrivalvis	1
Ulex europaeus	1
Xanthium occidentale (syn X. strumarium)	1
Xanthium spinosum	1
Mod	**3**
Nassella neesiana	1
Vachellia nilotica spp. indica (syn. Acacia nilotica)	1
Ziziphus mauritiana	1
High	**3**
Cirsium arvense	1
Lantana camara	1
Lantana montevidensis	1
Mod	**15**
Low	**7**
Arctotheca calendula	1
Bryophyllum delagoense	1
Carthamus lanatus	1

Inclusion in biocontrol assessment (yes, combined or no; no is selected when weed has Negligible cu	Yes

Row Labels	Count of Likelihood of success of biocontrol program (low, Moderate, high) (see guidelines)
Jatropha gossypiifolia	1
Physalis viscosa	1
Romulea rosea	1
Solanum elaeagnifolium	1
Mod	**5**
Asphodelus fistulosus	1
Calotropis procera	1
Euphorbia terracina	1
Lycium ferocissimum	1
Moraea flaccida and M. miniata	1
High	**3**
Marrubium vulgare	1
Opuntia & Cylindropuntia spp.	1
Prosopis spp.	1
High	**3**
Low	**1**
Carduus tenuiflorus and C. pycnocephalus	1
Mod	**1**
Cirsium vulgare	1
High	**1**
Chromolaena odorata	1
Grand Total	**55**